TECHNOLOGY DEPT.

TECHNOLOGY REVIEW

February 1958

PUBLIC LIBRARY
FEB 15 1958
DETROIT

Simplex

ANNOUNCES the C-L-X* Sheath

...an entirely new closed system that gives incomparable benefits in all types of cable installations

Simplex C-L-X is a Continuous Lightweight eXterior metallic sheath that is impervious to gases, chemicals and water. Its unique construction gives it a combination of properties that is unmatched by any cable system now manufactured in the United States.

C-L-X provides a completely sealed conduit — with "built-in" cable. C-L-X combines all the advantages of lead sheathed and interlocked armored cables. In addition, it has its own intrinsic qualities of great strength with extremely light weight. It is suitable for installation in trays or by clamps. C-L-X can be used aerially or buried directly in the ground. Its pliability permits ease of installation.

For more than a decade, this type of cable protection has given exceptional service in European installations. *Now, Simplex engineering has adapted C-L-X so that its scope of industrial applications is practically unlimited for modern American installations.* It is unequalled in situations where impermeability and durability are important.

Like all Simplex products, C-L-X is engineered for lasting quality and, therefore, *dependability*. Write for specific product data.

*(Continuous Lightweight eXterior, pronounced "Sealex")

LIVE BETTER ELECTRICALLY

Simplex WIRE & CABLE COMPANY

79 SIDNEY STREET, CAMBRIDGE 39, MASS.

"the American manufacturers of transoceanic telephone cables"

DESCRIPTIVE DATA

- **SIZE:** 1 inch diameter x 2¼ inches long
- **WEIGHT:** 3.8 ozs.
- **FULL SCALE RANGE:** 40 to 400 degrees/second
- **LINEARITY:** 0.1% of full scale to ½ range, within 2% to full range
- **RESOLUTION:** 0.01% full scale
- **DAMPING:** Fluid damped, temperature compensated
- **PICKOFF:** Variable Reluctance type, 400 - 6,000 cps
- **MOTOR EXCITATION:** 6.3 volts - 400 cps, 26 volts - 400 cps, 9 volts - 1,000 cps

Putting the sting exactly where it belongs

Gnat Rate Gyro
Shown actual size

GOLDEN GNAT

Miniature Rate Gyros for Missiles and Aircraft

Here is a precision, minature rate gyro. It's tiny . . . measures only 1 inch in diameter and 2¼ inches in length. It's rugged . . . withstands 100G shock and 10G vibration to 2,000 cps. It has a record of proven performance.

Even under the most severe environmental conditions the Golden Gnat will perform as required. To make this possible many unique design details have been incorporated. One such detail is the Gnat's *gold plated* steel housing for improved corrosion resistance and positive hermetic sealing.

Wherever the need exists for high performance miniature rate gyros such as for autopilot stabilization in missiles and aircraft, antenna stabilization and fire control applications, the Golden Gnat is ideally suited. Write for Bulletin GN . . . Minneapolis-Honeywell, Boston Division, Dept. 1, 1400 Soldiers Field Road, Boston 35, Mass.

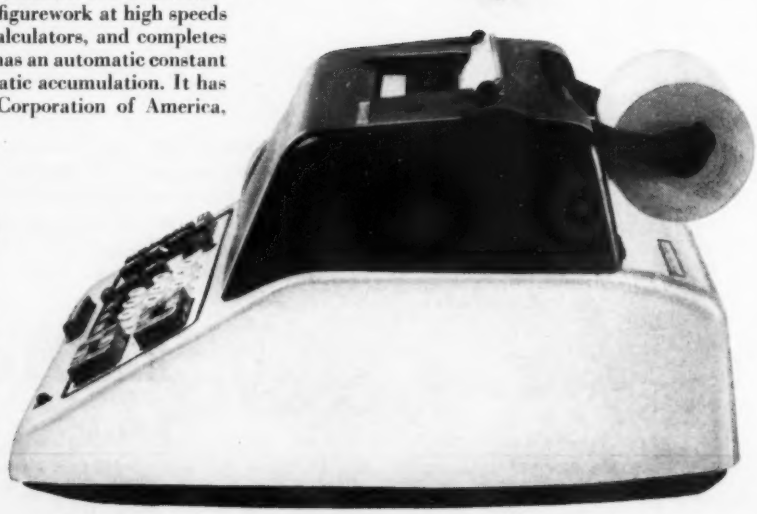
MINNEAPOLIS **Honeywell** H HONEYWELL

BOSTON DIVISION

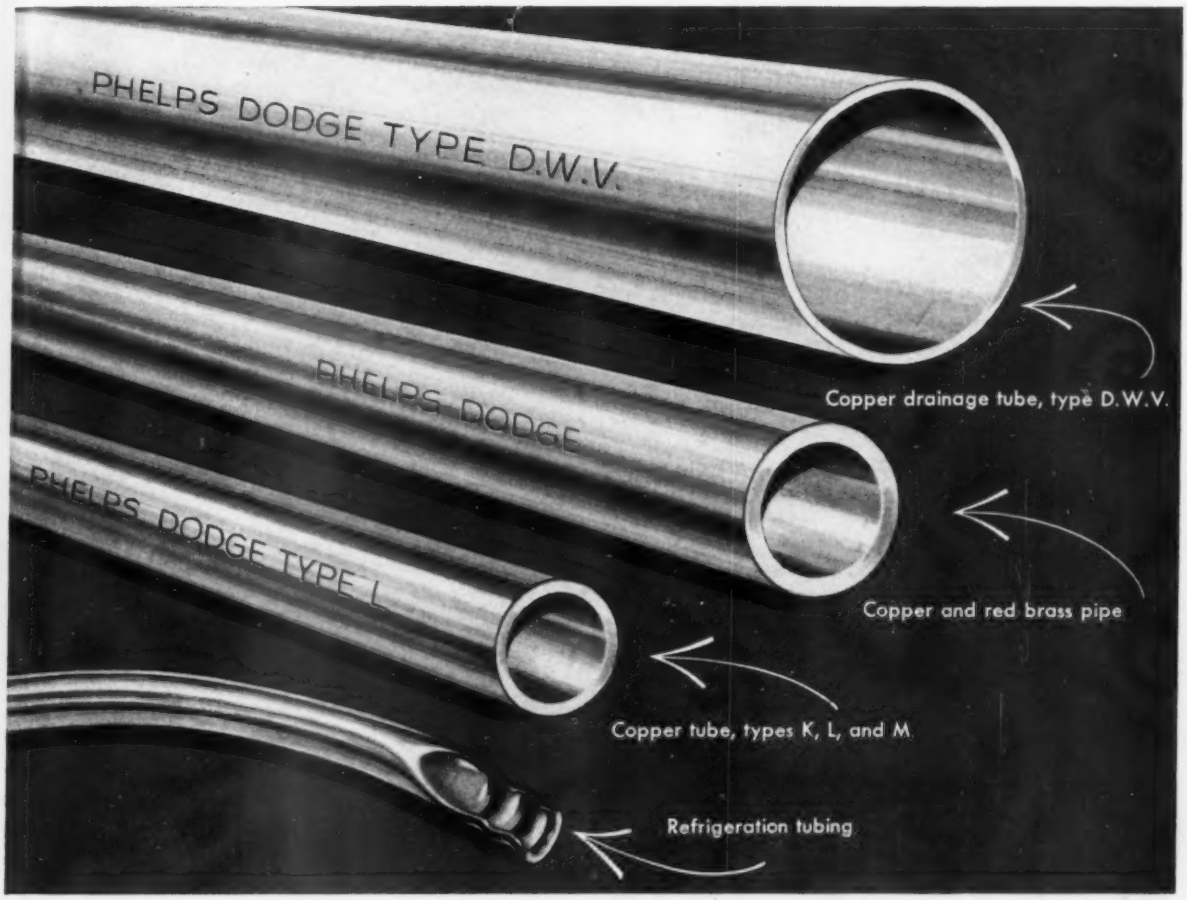
THE TECHNOLOGY REVIEW, February, 1958, Vol. LX, No. 4. Published monthly from November to July inclusive at Emmett Street, Bristol, Conn. Publication date: twenty-seventh of the month preceding date of issue. Annual subscription, $4.00: Canadian and Foreign subscription, $4.50. Entered as second-class matter December 23, 1949, at the Post Office, at Bristol, Conn., under the Act of March 3, 1879.

There are several reasons why the new Olivetti Tetractys is the most advanced of all desk calculators: It combines calculations without intermediate figure re-entry. It processes business figurework at high speeds formerly associated only with non-printing calculators, and completes all calculations by printing results on tape. It has an automatic constant and a memory. It has two registers for automatic accumulation. It has a single, simple 10-key keyboard. Olivetti Corporation of America, 580 Fifth Avenue, New York 36, New York.

olivetti



PHELPS DODGE COPPER WATER TUBE


PHELPS DODGE TYPE D.W.V.
PHELPS DODGE
PHELPS DODGE TYPE L
Copper drainage tube, type D.W.V.
Copper and red brass pipe
Copper tube, types K, L, and M
Refrigeration tubing

- **Highest Grade Copper**—from Phelps Dodge's own open-pit mines.
- **Expert Craftsmanhips**—assured by exacting quality control through every phase of tube manufacture.
- **Finest Tube Properties**—including precise uniformity of wall thicknesses—due to Phelps Dodge Hot-Forged, Extrusion Process.

PHELPS DODGE COPPER PRODUCTS CORPORATION

NEW YORK, N.Y. • LOS ANGELES, CALIFORNIA

PHYSICISTS, MATHEMATICIANS, ENGINEERS

are invited to join the Lincoln Laboratory scientists and engineers whose ideas have contributed to new concepts in the field of electronic air defense.

A brochure describing the following Laboratory programs will be forwarded upon request.

HEAVY RADARS
MEMORY DEVICES
TRANSISTORIZED DIGITAL COMPUTERS
SCATTER COMMUNICATIONS
SOLID STATE
(air-borne early warning) **AEW**
(semi-automatic ground environment) **SAGE**
SYSTEMS ANALYSIS

In certain of these programs, positions of significant professional scope and responsibility are open to men and women with superior qualifications.

RESEARCH AND DEVELOPMENT
MIT LINCOLN LABORATORY
Box 28, Lexington 73, Massachusetts

custom-built equipment for the mechanical and process industries

We develop special equipment and machines from ideas to blueprints — to prototypes — to pilot plants — to the final product or process. Our technical staff and plant facilities are geared to handle the most intricate jobs all the way from small scale laboratory equipment up to contracts in excess of $1,000,000.

Phone TWinbrook 3-6800 or write to:

Artisan METAL PRODUCTS, INC.

73 POND STREET, WALTHAM 54, MASS.

For a comprehensive summary of our work and the equipment we make, write for our brochure "Process Equipment".

Designers and manufacturers of

AUTOCLAVES · CONDENSERS AND HEAT EXCHANGERS · DISTILLATION EQUIPMENT · EXPERIMENTAL EQUIPMENT · EVAPORATORS · JACKETED KETTLES · MIXERS · PIPE, PIPE COILS, AND BENDS · REACTORS · SPECIAL MACHINERY · TANKS

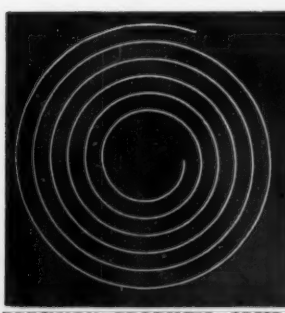
THE TABULAR VIEW

Key to Leadership. — Major address of the Regional Conference held in Pittsburgh on December 7 was given by ACTING PRESIDENT J. A. STRATTON, '23, whose topic was "Universities — A Key to America's Leadership." Dr. Stratton's article in this issue of The Review (page 201) adapts for the printed page the major portion of that address, delivered on the anniversary of the Pearl Harbor attack and at a time when the nation was concerned with launching of two Russian satellites. Dr. Stratton critically analyzed the situation which confronts this nation. "We, in America," he said, "have been curiously plagued by the fear of an intellectual elite. . . . We have tended to distrust intellectual achievements that are not to be had by everyone on equal terms. There has been too little pride and understanding among Americans of the quality of excellence. . . . Let us not forget that the traditional function of the university is to teach and to provide teachers as well as to advance learning." Dr. Stratton is particularly well qualified to deal with this topic for he has been engaged in educational pursuits all his life. After one year at the University of Washington, Dr. Stratton came to M.I.T. where he received the S.B. degree in Electrical Engineering in 1923. He then spent a year at the Universities of Grenoble and Toulouse, and returned to M.I.T. as a research associate in electrical communications, receiving the S.M. degree in 1925. Dr. Stratton was appointed assistant professor of electrical engineering at M.I.T. in 1928. In 1930 he transferred to the Department of Physics and became professor of physics in 1941

Following World War II, he established the M.I.T. Research Laboratory of Electronics and served as its head until 1949 when he was appointed to M.I.T.'s newly created post of Provost. He became vice-president and a member of the M.I.T. Corporation in 1951, and chancellor in 1956. Upon Dr. Killian's appointment as Special Adviser to the President for Science and Technology, Dr. Stratton was appointed acting president of M.I.T., in addition to his post as chancellor.

Invention in Flight. — The June, 1954, issue of The Review carried an article on the future of discovery and invention in which it was pointed out that "overemphasis on applied research at the present time, at the expense of research in basic science, is a practice well worth serious attention." In this issue (page 204) the same student of the development of science and technology, J. L. B. BLIZARD, '49, examines invention in the broad field of flight. It is concluded that greatest advancement occurs when there is full freedom to exchange ideas, and

(Concluded on page 186)



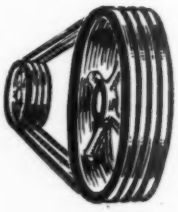
"Precision-Gauged" HAIRSPRINGS

More than 20 years' experience making all types of hairsprings for critical instrument applications. High volume production with absolute uniformity.

PRECISION PRODUCTS COMPANY INC OF WALTHAM
WALTHAM 54 • • MASSACHUSETTS

from Tires – and Tubes – and Rubber Clothes

to Belts – and Boots – and Garden Hose



Better RUBBER Products are made with CABOT

VULCAN® and STERLING®

THE INDUSTRY'S TOP QUALITY FURNACE CARBON BLACKS

WORLD'S MOST COMPLETE VARIETY OF OIL AND GAS FURNACE CARBON BLACKS

VULCAN 9	Super-Abrasion Furnace	(SAF)
VULCAN 6	Intermediate Super-Abrasion Furnace	(ISAF)
VULCAN 3	High Abrasion Furnace	(HAF)
VULCAN XC-72 (PELLETS) (FLUFFY)	Extra-Conductive Furnace	(ECF)
VULCAN SC	Super-Conductive Furnace	(SCF)
VULCAN C	Conductive Furnace	(CF)
STERLING 99	Fine Furnace	(FF)
STERLING SO	Fast Extruding Furnace	(FEF)
STERLING V	General Purpose Furnace	(GPF)
STERLING L **STERLING LL**	High Modulus Furnace	(HMF)
STERLING S	Semi-Reinforcing Furnace	(SRF)
STERLING NS (NON-STAINING)		
STERLING R (FLUFFY)		
PELLETEX	Semi-Reinforcing Furnace	(SRF)
PELLETEX NS (NON-STAINING)		
GASTEX (FLUFFY)	Semi-Reinforcing Furnace	(SRF)

Remember too, that Cabot is the world's only manufacturer of a complete variety of ALL types of carbon black . . . channel, furnace and thermal . . . representatives in all principal cities or contact your nearest Cabot office for further details –

CABOT®

GODFREY L. CABOT, INC.

77 FRANKLIN ST., BOSTON 10, MASS.

AKRON
518 Ohio Building
Akron 8, Ohio

NEW BRUNSWICK
46 Bayard Street
New Brunswick, New Jersey

CHICAGO
141 W. Jackson Boulevard
Chicago 4, Illinois

NEW YORK
60 East 42nd Street
New York 17, New York

CABOT CARBON COMPANY SALES OFFICE
1309 Main Street
Dallas, Texas

How Curtis helped a design engineer "BEAT THE HEAT"

This single universal joint in a ribbon-stripping machine was operated at a 34° angle. The joint heated up, wear was excessive. (Curtis Joints have been tested at angles up to 37°, but we do not recommend angles greater than 30°.)

Curtis engineers recommended a *double* Curtis joint, which reduced the angle to 17° per joint. Result: no overheating, improved efficiency, longer life.

You can depend on Curtis engineering in any problem of angular power transmission. And you can depend on

CURTIS UNIVERSAL JOINTS because our catalog torque and load ratings are substantiated by constant tests under production conditions.

14 SIZES ALWAYS IN STOCK
3/8" to 4" O.D.
(6" joints on special order)

Not sold through distributors. Write direct for free engineering data and price list.

TRADE MARK **CURTIS**
UNIVERSAL JOINT CO., INC.
8 Birnie Avenue, Springfield, Mass.
As near to you as your telephone

EXCLUSIVELY A MANUFACTURER OF UNIVERSAL JOINTS SINCE 1919

FREE BOOKLET TELLS WHAT CO_2 CAN DO FOR YOU

agriculture
chemistry
metals
electronics
refrigeration
food
drugs
textiles
rubber

There's practically no end to the important jobs that CO_2—combined with Liquid Carbonic savvy—is doing. Chances are this combination can come up with some surprising answers for you, too. For scores of CO_2 applications, covering all industry, send for LIQUID's new free booklet, "Applications Unlimited." Just use the coupon below.

MAIL THIS COUPON

LIQUID CARBONIC
DIVISION OF GENERAL DYNAMICS CORPORATION
3100 South Kedzie Avenue, Chicago 23, Illinois
Send me my free copy of "Applications Unlimited."

Name_____
Company_____
Position_____
Address_____
City_____ Zone____ State_____

(Concluded from page 184)

that great possibilities lie ahead for the congregation of nations best able to utilize the benefits of its men of talent. In these days of intercontinental missiles and interservice fizzles, these conclusions have more than purely academic interest. After receiving the A.B. degree with high honors from the University of Rochester in 1945 and the Ph.D. degree from M.I.T. in 1949, Dr. Blizard taught at Hofstra College, the University of Connecticut, and Vassar College, and has done medical research at the New England Institute for Medical Research. At present, Dr. Blizard is assistant physicist at the M. D. Anderson Cancer Hospital of the University of Texas.

Education in Russia. — For several years, ALEXANDER G. KOROL, in the Institute's Center for International Studies, has been engaged in a study of the Russian educational system, resulting in a book entitled *Soviet Education for Science and Technology*, which has recently been published jointly by The Technology Press and John Wiley and Sons, Inc. The article on page 208 of this issue is compiled from extracts of this volume and published with the approval of the author and the publisher. Admittedly, extracts selected from a longer work and pieced together can hardly do justice to the longer study. Yet The Review's condensation supports Mr. Korol's thesis that, designed solely to serve Party interests, the Soviet technical training is rugged, proficient, and skillfully used to expand Communist power in its war against the free democratic societies. It is not Soviet education that the free nations need fear, Mr. Korol concludes, but the misuse of power by the Communist Party. Mr. Korol is particularly well suited to a study of Russian education. He was born in Irkutsk in 1900, but came to the United States (of which he is a naturalized citizen) in 1920. He studied engineering at the University of Washington and has the A.B. and M.A. degrees in economics from Columbia University. In 1952 he received the Certificate in Soviet Studies from Columbia. In the summer of 1951 he was assistant to the Field Director of Harvard Refugee Interview Project. Since 1952 he has been a member of the Senior Research Staff at the Center for International Studies at M.I.T.

Chas. Pfizer & Co., Inc.
Office and Laboratory

Good men—good job

You know how scarce good executive personnel is today.

In the construction field, the best men gravitate to builders with a record for permanency and good organization.

We have served American industry on small and large building projects for the past 40 years.

W. J. BARNEY CORPORATION
Founded 1917
INDUSTRIAL CONSTRUCTION
101 Park Avenue, New York
Alfred T. Glassett, '20, President

When the Pressure Is On . . .

. . . for more efficient processing equipment operating at higher pressures and temperatures, experienced fabricating skills are important. This pressure vessel in carbon steel, designed to withstand 300 psi at 270°, is one of many types of vessels Graver fabricates to customer requirements in conformance with the ASME Code. Eminently satisfactory performance and long-life is assured when Graver's century-aged skills are employed. When high pressures and temperatures are involved, it is a sound decision to discuss your requirements with Graver.

GRAVER®

Building for the Future on a Century of Craftsmanship in Steels and Alloys

GRAVER TANK & MFG. CO., INC.

EAST CHICAGO, INDIANA

New York • Philadelphia • Edge Moor, Delaware • Pittsburgh
Detroit • Chicago • Tulsa • Sand Springs, Oklahoma • Houston
New Orleans • Los Angeles • Fontana, California • San Francisco

Full-time, off-the-job GRADUATE

STUDY CENTER. New York's Coliseum Tower houses one of three special study centers set aside for W.E.'s Graduate Engineering Training Program. Other centers are in Chicago and Winston-Salem, N. C. Product design principles are one of the many technical subjects our engineers cover in *Introduction to Western Electric Engineering*, the first phase of the program.

ENGINEERING TRAINING
helps speed careers at Western Electric

Right now, Western Electric engineers are back "on campus" in a unique new Graduate Engineering Training Program. They're attending courses at special study centers established by the company in Chicago, New York and Winston-Salem, N. C. It's a rare chance to study advanced engineering and get full pay at the same time.

These "students" are guided by a teaching staff of top Western Electric engineers, outside experts and professors from leading universities. They're learning the latest technical developments . . . boning up on everything from manufacturing processes to computer applications.

When the program reaches its peak, some 2,000 to 3,000 Western Electric engineers will attend each year . . . studying in an atmosphere as close to a university graduate school as is practical for industry.

This engineering "university" was born because of the ever-increasing complexity of Western Electric's job as the manufacturing and supply unit of the Bell Telephone System. Today W. E. engineers are right in the middle of exciting fields like microwave radio relay, electronic switching and automation. Graduate engineering training is designed to spur their development and advancement throughout their entire careers.

How Graduate Engineering Training would work for you

The program gets under way after approximately six months on-the-job experience. First off:

1. A nine-week *Introduction to Western Electric Engineering* helps you learn about your W.E. engineering field, sharpens your skills in getting ideas across. Technical subjects include communications systems, product design principles, military electronic systems.
2. Another nine-week program, *General Development*, starts after your first year with us, helps broaden and strengthen your engineering background. Besides technical subjects like engineering statistics, measurements and instrumentation, and electronics, you receive grounding in human relations and the socio-economic importance of engineering.
3. To meet continuing needs for formalized technical training, *Advanced Development* offers four-week courses tailored to the individual needs of the engineers selected to attend. These courses are designed to help develop creative engineering abilities. Computer applications, switching theory, feedback control systems, and semi-conductor devices and circuits are sample topics covered in this phase.

Besides taking part in the Graduate Engineering Training Program, engineers are eligible for our Tuition Refund Plan for after hours study at nearby colleges.

In short, there's a unique opportunity at Western Electric to develop a professional career . . . and work in the exciting world of communications.

Western Electric

MANUFACTURING AND SUPPLY UNIT OF THE BELL SYSTEM

Knowledge born in the classroom often sparks on-the-job ideas. These engineers are working on transistor manufacturing problems.

OPPORTUNITIES FOR ENGINEERING GRADUATES

(Supervisory and administrative opportunities exist in each field)

Analysis for manufacturing operations:
Machine and tool requirements—M.E., E.E.; Space requirements—M.E., I.E.; Test facility requirements—E.E.; Personnel requirements—I.E.; Electric power, light and heat requirements—E.E.; Raw material requirements—Chem. E., Met. E., Phy. Sc.; Procedures and processes—M.E., I.E., Time and motion studies—I.E., Investigation of manufacturing difficulties—M.E.; Quality control—M.E., E.E.

Planning telephone central offices:
Equipment requirements — E.E.; Power and cable requirements—E.E.

Development and design:
New machines and tools—M.E., E.E.; Material handling methods—M.E., I.E.; New equipment and processes—M.E., E.E.; Repair shop methods—M.E.; Testing facilities—E.E.; Testing methods—E.E.; Job evaluation studies—I.E.; Wage incentive studies—I.E.; Production control studies—I.E.; Improved chemical processes—Chem. E., Met. E., Phy. Sc.; New application for metals and alloys—Chem. E., Met. E., Phy. Sc.; Raw material test procedures—Chem. E., Met. E., Phy. Sc.; Service to military on electronic devices—E.E.

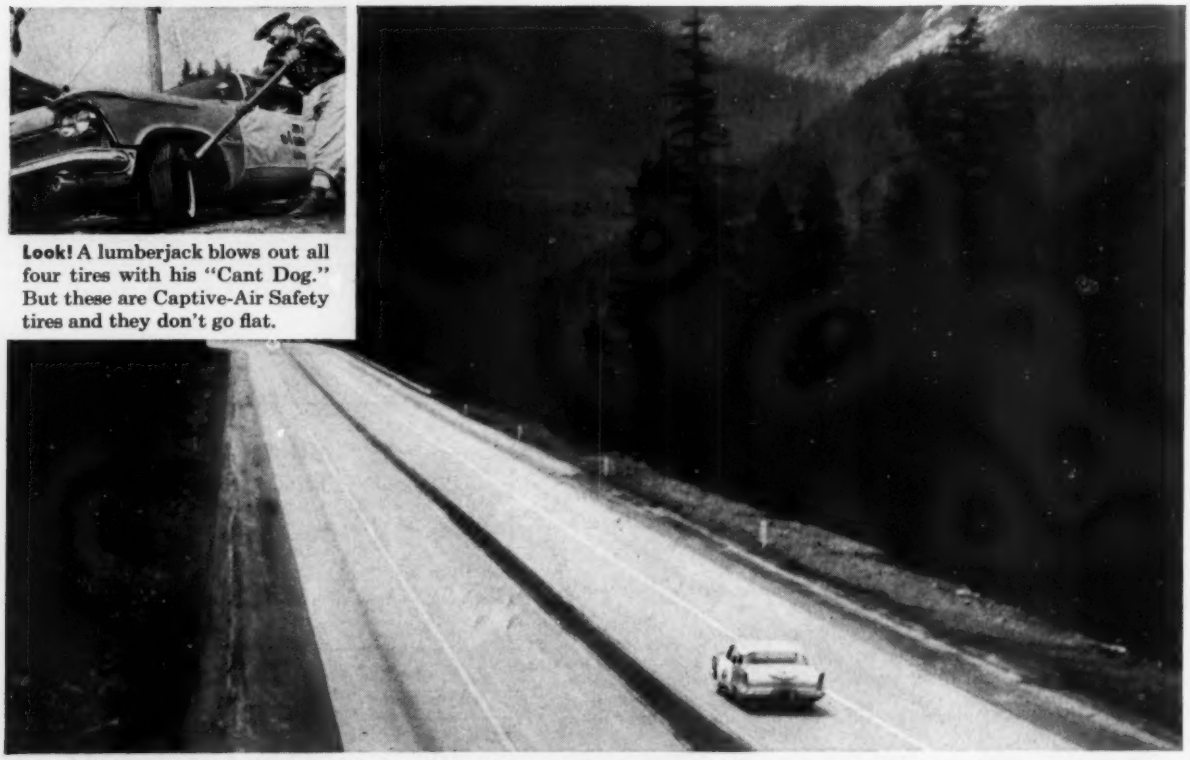
For further information write: Engineering Personnel, Room 1034, 195 Broadway, New York 7, N. Y.

• Western Electric has major manufacturing plants at Chicago and Decatur, Ill.; Kearny, N. J.; Baltimore, Md.; Indianapolis, Ind.; Allentown and Laureldale, Pa.; Burlington, Greensboro and Winston-Salem, N. C.; Buffalo, N. Y.; North Andover, Mass.; Lincoln and Omaha, Neb.; St. Paul and Duluth, Minn. Distribution Centers in 32 cities. Installation headquarters in 16 cities. General headquarters: 195 Broadway, New York, N. Y. Also Teletype Corp., Chicago 14, Ill.

320 Miles on Four Blown-Out Tires!

No swerve! No sway! No forced stops!

Look! A lumberjack blows out all four tires with his "Cant Dog." But these are Captive-Air Safety tires and they don't go flat.

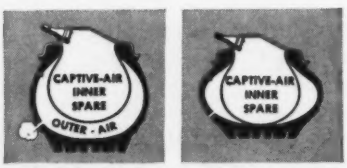


Spokane to Seattle on 4 blown-out tires. We're all alone in Washington's Snoqualmie Pass. *One* blowout with any ordinary tire could pitch a car over the deep drop-off ahead. But our Captive-Air Safety tires, each with its multi-ply nylon "spare," let us roll along safely—*on air*. Aren't these the tires for your family car?

Goodyear's exclusive double-air chamber principle gives you the greatest road safety ever! The nylon Captive-Air "inner spare" virtually ends roadside tire changes in the event of a blowout or puncture!

Every Captive-Air Safety tire has a built-in spare designed to carry you safely after a blowout or puncture.

With this double-air chamber tire, you can drive on a "flat" 100 miles or more with no stopping—no inconvenience—no danger from roadside tire-changing. See it at your Goodyear dealer's—liberal allowance for your present tires. Goodyear, Akron 16, Ohio.



Only the air in the outer chamber escapes if the Captive-Air tire is cut, torn or blown out.

Reserve air in the built-in spare supports the car—lets you drive on for 100 miles or more.

Captive-Air gives you a spare where you need it... in the tire on the road

GOODYEAR

MORE PEOPLE RIDE ON GOODYEAR TIRES THAN ON ANY OTHER KIND!

Captive-Air, T. M., The Goodyear Tire & Rubber Company, Akron, Ohio

THE TECHNOLOGY REVIEW

TITLE REGISTERED, U. S. PATENT OFFICE

EDITED AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

CONTENTS for FEBRUARY, 1958, Vol. 60, No. 4

THE MATTERHORN — Front Cover
Photograph by Paul J. Woolf

STATUE OF WASHINGTON, BOSTON PUBLIC GARDEN — Frontispiece 192
Photograph by Raymond E. Hanson

UNIVERSITIES — A KEY TO AMERICA'S LEADERSHIP — By J. A. Stratton 201
Major address at Regional Conference in Pittsburgh stresses need to cultivate taste for learning, with emphasis on excellence of achievement

INVENTION IN FLIGHT — By J. L. B. Blizard 204
Progress in man's flight demonstrates that the greatest achievements occur under conditions of unimpeded flow of knowledge

SOVIET EDUCATION FOR SCIENCE AND TECHNOLOGY — By Alexander G. Korol 208
Designed solely to serve Party interests, Soviet technical training is rugged, proficient, and skillfully used to expand Communist power in the war against free democratic societies

THE TABULAR VIEW — 184
Contributors and contributions to this issue

THE TREND OF AFFAIRS — 193
Relating to the Massachusetts Institute of Technology

This St. Augustine house, built in the late 1500's, is said to be the oldest in North America.

Photograph by Ward Allan Howe

EDITOR:
B. Dudley
BUSINESS MANAGER:
R. T. Jope
CIRCULATION MANAGER:
D. P. Severance
EDITORIAL ASSOCIATES:
Paul Cohen
J. R. Killian, Jr.
F. W. Nordsiek
J. J. Rowlands
EDITORIAL STAFF:
Ruth King
BUSINESS STAFF:
Madeline R. McCormick
PUBLISHER:
H. E. Lobdell

Published monthly from November to July inclusive on the twenty-seventh of the month preceding the date of issue, at 60 cents a copy. Annual subscription, $4.00; Canadian and foreign subscription, $4.50. Published for the Alumni Association of the M.I.T.; Gilbert M. Roddy, President; H. E. Lobdell, Executive Vice-president; John J. Wilson, D. Reid Weedon, Jr., Vice-presidents; Donald P. Severance, Secretary-Treasurer. Published at Hildreth Press, Inc., Bristol, Conn. Editorial Office, Room 1-281, Massachusetts Institute of Technology, Cambridge 39, Mass. Entered as second-class mail matter at the Post Office at Bristol, Conn. Copyrighted, 1958, by the Alumni Association of the Massachusetts Institute of Technology. Three weeks must be allowed to effect change of address, for which both old and new addresses should be given.

Photograph by Raymond E. Hanson

Equestrian Statue of George Washington, Boston Public Garden

"To be prepared for war is one of the most effectual means of preserving peace."

— George Washington's first annual address to Congress

The Technology Review

VOL. 60, NO. 4 FEBRUARY, 1958

The Trend of Affairs

Pittsburgh Regional Conference

■ Coming on Pearl Harbor Day, and the day after Vanguard had sputtered and burned in Florida, the 11th Regional Conference, sponsored by the M.I.T. Club of Western Pennsylvania, found Alumni and speakers in a grave mood with respect to the problems of science and technology. The conference was held on December 7, 1957, at the Penn-Sheraton Hotel in Pittsburgh.

Edward J. Hanley, '24, and John Lawrence, '32, as co-chairmen of the Regional Conference, with Thomas I. Stephenson, 3d, '45, as deputy chairman, planned a particularly significant program in which six members of the Institute's Faculty traveled from Cambridge to Pittsburgh for this important event.

Speakers from the Institute included: Morris Cohen, '33, Professor of Physical Metallurgy, who spoke on "Metallurgy in Russia and America"; Irwin W. Sizer, Professor of Biochemistry, whose subject was "Life and Death at the Molecular Level"; George R. Harrison, Dean of the School of Science, speaking on "Science and the World Outlook"; Jerrold R. Zacharias, Professor of Physics, who talked on "Twentieth Century Physics in the High School"; E. P. Brooks, '17, Dean of the School of Industrial Management, who discussed "Today's Plans for Tomorrow's Management"; and J. A. Stratton, '23, Acting President of the Institute, who spoke on "Universities — A Key to America's Leadership." Dr. Stratton spoke in place of President Killian whose assignment, as Special Assistant to President Eisenhower for Science and Technology, prevented his attendance at the conference. B. Richard Teare, Jr., Dean of Engineering and Science, Carnegie Institute of Technology, presided at the morning session, and Max A. Lauffer, Dean of the Division of Sciences, University of Pittsburgh, presided at the afternoon session.

Of special interest to Pittsburgh technologists was a report from Professor Cohen on what he had seen in a recent tour of Russian steel mills, laboratories, and technological institutes.

"In Moscow alone," he said, "there are 4,500 students studying metallurgy and this is more than we have in the entire country, both graduate and undergraduate. The Soviets are training metallurgists seven times faster than we are.

"Metallurgy," he observed, "sits just about at the top of the heap" of Russian technology and "the main thing to keep in mind is that the bulk of steel production is being plowed back into the industrial system . . . Sputniks and atomic-powered icebreakers represent only 10 per cent of the technological potential — the part of the iceberg that is visible. The other 90 per cent, which we do not see, is a solidly based educational system and love for knowledge."

Conference registrants also heard an informative, illustrated address by Professor Sizer, Head of the Department of Biology. New research in the life sciences was described by Dr. Sizer, whose article in the June, 1957, issue of The Review covered similar subjects.

Dean Harrison gave what might be considered the keynote speech at the luncheon, saying: "I believe the next two years are the most dangerous in the history of free society, and that the decade after that will show only a slow relaxation of the danger, and that only if Americans wake up faster than we are waking up at present.

"Khrushchev has already announced that the Russians have won the technological race, and if we keep on the course we are still heading in, he is right.

"The missile problem is only a small part of the difficulty. Slowly, under the influence of increasing wealth, the moral fiber of America has been tenderized by the sweet acids of success."

In the afternoon session, Professor Zacharias, chairman of a recently established Physical Science Study Committee, gave a stimulating account of the work of this committee whose assignment includes preparation of a new high school textbook on physics, a teacher's manual, films, and inexpensive and easily constructed laboratory apparatus which high school students can build to investigate the nature of the physical world. Early work of the Physical Science Study Committee was reported by Dr. Zacharias in the July, 1957, issue of The Review.

Dean Brooks developed the theme that tomorrow's industrial leaders must be prepared to cope with the phenomenon of bigness, with increased use of capital

Associated Photographers

A few of the many Alumni who played prominent roles in the Regional Conference held at Pittsburgh on December 7 are shown on this page. At the left, the Institute's Acting President J. A. Stratton, '23 (left), congratulates Irving W. Wilson, '11 (center), who received citation from Alumni Association President Gilbert M. Roddy, '31 (right). Right-hand illustration shows Edward J. Hanley, '24, General Co-Chairman of the conference (left), William J. Sherry, '21, who arranged last year's (February 2) conference in Tulsa (center), and J. Robert Ferguson, Jr., '37, of Pittsburgh.

and labor in the production process, and with many technical, social, and economic complexities brought about by research in other fields. Relating his message specifically to recent world events, Dean Brooks declared that Sputnik is also a challenge to management, saying, "In order to rewin supremacy, we will need to make a great scientific and technological effort. But the effort will not be enough unless it is well administered."

Raymond Mancha, '26, was toastmaster at the banquet in the evening, at which Acting President Stratton expressed serious concern with general and technological education in the United States. His address appears on page 201 of this issue of The Review.

During the dinner, Gilbert M. Roddy, '31, President of the Alumni Association, presented a citation to Irving W. Wilson, '11, chairman of the board of the Aluminum Company of America. Mr. Roddy described Mr. Wilson as a "loyal alumnus of the Class of 1911, an electromechanical engineer and captain of industry distinguished for his steadfast devotion to the advancement of education and society."

Associated Photographers

Thomas I. Stephenson, 3d, '45, (left), Deputy Chairman of the Pittsburgh Regional Conference and President of the M.I.T. Club of Western Pennsylvania; Ralph V. Davies, '16 (center), member, Regional Conference Steering Committee; and Raymond Mancha, '26, toastmaster at the evening banquet (right).

Responding, Mr. Wilson said, "Fifty years ago I had no realization of what my choice of schools would mean to me. In looking back, however, I can now say that I could not possibly have been better advised or more fortunate in that selection. Throughout the years that have followed, M.I.T. has had an ever-increasing place in my affection and esteem."

International Communications

■ Daniel Lerner, a leading sociologist and educator, has been appointed to a new professorship in international communication in the Department of Economics and Social Science. His appointment to the new chair, established under a 1956 Ford Foundation grant, was announced early in December by J. A. Stratton, '23, Acting President of M.I.T. Dr. Lerner has been associate professor of sociology at the Institute.

Working with M.I.T.'s Center for International Studies, Dr. Lerner will apply research findings on international communication to a new teaching program in the Department of Economics and Social Science. This co-ordinated program in the field of international communication was also made possible by the $560,000 grant, which provides long-term support for two new professorships in the behavioral sciences.

Professor Lerner has been a senior member of the Institute Faculty and research staff since 1953. He was formerly professor of sociology at Columbia and Stanford Universities, executive secretary and research director of the International Studies Project at the Hoover Institute, and research director and founder of the Institut d'Etudes Européennes in Paris. He received his A.B., M.A., and Ph.D. from New York University.

Dr. Lerner's books include *Propaganda in War and Crisis, The Policy Sciences* (with Harold Lasswell), and *France Defeats EDC* (with Raymond Aron). *Modernizing the Middle East,* a study of communication patterns and social change in the Middle East, will be published next spring, and Dr. Lerner is now completing a study of French attitudes toward the movement for European unification.

Individuals Noteworthy

■ Year-end news included the 31 promotions, elections, or appointments which follow:

J. Howard Pew, '03, as a Director, Sun Oil Company . . . *Starr W. Stanyan, '14,* as a Director, Hoague-Sprague Corporation, Lynn, Mass. . . . *Alfred V. Coleman, '15,* as President, New England Power Service Company . . .

Marshall B. Dalton, '15, and *Gilbert M. Roddy, '31,* respectively, as Chairman and President, Boston Manufacturers Mutual and Mutual Boiler and Machinery Insurance Companies . . . *Max I. Woythaler, '15,* as President, Lombard Governor Corporation . . . *Stanley M. Lane, '17,* as President, New England Baptist Hospital . . .

Robert L. Sumwalt, '20, as Acting President, University of South Carolina . . . *Clinton B. F. Brill, '22,* as Chairman, New York State Thruway Authority . . . *Robert L. Hershey, '23,* as a Director, Vice-president, and member of the Executive Committee, E. I. du Pont de Nemours and Company . . .

William L. Stewart, Jr., '23, and *Robert T. Collier, '18,* respectively, as Chairman and President, Collier Carbon and Chemical Corporation . . . *Ralph F. Gow, '25,* as a Trustee, Norwich University . . . *Howard R. Batchelder, '28,* as Chairman, Div. of Gas and Fuel Chemistry, American Chemical Society . . .

M. David Haynes, '28, as Superintendent, Delaware Refinery, Tidewater Oil Company . . . *Samuel J. Levine, '29,* as Manager, Aircraft Nuclear Propulsion Department, General Electric Company, Idaho Falls, Idaho . . . *Alfred Ziegler, '31,* as Manager, Palmer Plant, Colorado Fuel and Iron Company . . .

John Lawrence, '32, as Executive Vice-president, Dresser Industries, Inc. . . . *James R. Merrill, '33,* as Manager, Santa Barbara Laboratory, Raytheon Manufacturing Company . . . *Edwin R. Gilliland, '33,* as a Director, American Institute of Chemical Engineers . . . *Edmund Q. Sylvester, 2d, '34,* as a Director, Shipbuilders Council of America . . .

Stephen M. MacNeille, '37, as Director of Research, American Optical Company . . . *Captain Floyd B. Schultz, U.S.N., '37,* as Commanding Officer, San Francisco Naval Shipyard . . . *Elliott M. Gordon, '39,* as President, Towle Manufacturing Company . . . *Charles J. Jeffus, '39,* as Business Manager, Nuclear Division, The Martin Company . . .

Russell L. Haden, Jr., '40, as General Manager, Chemicals Division, Virginia-Carolina Chemical Corporation . . . *Walter M. Palmer, '40,* as Production Superintendent, Johns-Manville Products Corporation . . . *James D. McNitt, '41,* as Vice-president and General Manager, Bristol Laboratories . . . *Captain Francis B. Merkle, U.S.N., '41,* as Commanding Officer and Director, Naval Boiler and Turbine Laboratory, Philadelphia . . . *Ralph G. Mork, '42,* as Director of Experimental Development, International Business Machines World Trade Corporation . . . *Thornton E. Smith, '45,* as President, Kulm, Smith, and Harris, New York.

■ Special honors recently announced or awarded to Alumni include:

To *Walter L. Whitehead, '13,* an honorary doctorate of science, by St. Francis Xavier University, Nova Scotia . . . to *Stanley H. Osborn, '15,* the C.-E. A. Winslow ['98] Award, by the Connecticut Public Health Association . . .

To *Crawford H. Greenewalt, '22,* the William Procter Prize for Scientific Achievement, presented at the annual meeting of the American Association for the Advancement of Science . . . to *Edward N. Dingley, Jr., '26,* the honorary grade of Fellow, by the American Institute of Electrical Engineers . . .

To *Charles S. Draper, '26,* the Holley Medal for a "great and unique act of engineering genius," the discovery of a new principle for controlling guns fired from moving platforms at moving targets, by the American Society of Mechanical Engineers . . . to *Charles W. Jerome, '34,* the grade of Fellow, by the Illuminating Engineering Society . . .

To *Louis H. Roddis, Jr., '44,* an Outstanding Service Award, by the U.S. Atomic Energy Commission . . . to *Paul Talalay, '44,* the 1957 Theobald Smith Award in Medical Sciences, for "demonstrated research in the field of medical sciences, taking into consideration independence of thought and originality," by Eli Lilly and Company . . .

Included in the 75 leading radio engineers and scientists named for 1958 as Fellows of the Institute of Radio Engineers were the following 14 Alumni: *John B. Russell, Jr., '28; Jacob Millman, '32; Harner Selvidge, '32; Albert C. Hall, '37; Arnold P. G. Peterson, '37; Pierre M. Honnell, '39; Rodolfo M. Soria, '39; Stewart E. Miller, '40; David E. Sunstein, '40; Nathaniel Rochester, '41; Wilbur B. Davenport, Jr., '43; Lotfi A. Zadeh, '46; Henry J. Riblet, '48; and David F. Winter, '48.*

On the Horizon

March 1, 1958 – 12th M.I.T. Alumni Regional Conference, Washington, D.C. (For further information, consult T. K. Meloy, '17, 3000 Arlington Boulevard, Falls Church, Va.)

March 13–15, 1958 – 10th Annual Fiesta, M.I.T. Club of Mexico, Mexico City, D.F. (For reservations, consult Clarence M. Cornish, '24, Margaritas 139, Villa Obregon, Mexico 20, D. F., Mexico.)

June 16, 1958 – 24th Alumni Day, 1958, M.I.T. Campus in Cambridge.

Matthew R. Copithorne: 1880–1957

■ Matthew R. Copithorne, Associate Professor of English, Emeritus, died at his Cambridge home on December 4, 1957. For 33 years he had served on the Faculty of the Department of English and History. He was 77 years old.

Widely known as a lecturer on prose and poetry, Professor Copithorne was a native of Cambridge and a graduate of Harvard University. He joined the Institute staff in 1918 as an instructor and was appointed assistant professor of English in 1928 and associate professor in 1938. After his retirement in 1946, he served for five years as lecturer in the Department of English and History.

Cambridge and Moscow

■ The 327th meeting of the Alumni Council, at which President Gilbert M. Roddy, '31, presided at the Faculty Club on November 25, was attended by 174 members and guests. A substantial amount of business was quickly disposed of in order that Council members could hear an address on "M.I.T. – A City within a City" by Philip A. Stoddard, '40, Vice-treasurer, and an illustrated talk, "A Metallurgist in Russia" by Nicholas J. Grant, '44, Professor of Metallurgy.

Mr. Stoddard described various aspects of the day-to-day operations of the Institute and some of the physical changes anticipated in the future. He described the Institute as it might appear to an imaginary new City Manager who had come to take over the assignment of managing M.I.T.'s Physical Plant. The size of population of this community – 115 acres and 11,000 people, respectively – gives no idea of the services which must be provided.

M.I.T. is a fast-growing place. In the past 10 years, over $20,000,000 value of new plant construction has taken place and the plant has increased in area by one-third. In the past 15 years, M.I.T. has added a building area (new or acquired) equivalent to the John Hancock Building, so that the Institute finds itself with almost 82 acres of building area.

The plant budget for normal operations and repairs for last year amounted to nearly $2,500,000, requiring a payroll of 325 men and women who comprise the plant department, including matrons, janitors, mailmen, painters, electricians, and so on. In addition to the vigorous educational program involving classrooms, laboratories, and a myriad of research activities, there are also many public service activities conducted on the lot during the evening. There are about 20 class sessions per week conducted by Lowell Institute. There are over 100 evening class sessions per week involving 5,000 to 6,000 students under the University Extension Classes of the Commonwealth.

In addition, there are meetings of many professional societies and of several military reserve organizations and other public interest groups.

The Lowell Institute, the University Extension Classes, and these other public interest groups account for an average of about 30 meetings an evening in the main educational plant.

The night cleaning force of nearly 100 persons has to do the bulk of its work from 11:00 P.M. to 7:00 A.M. because of the difficulty of finding any earlier free time for much of the Institute's 80 acres of buildings. Cleaning supplies and equipment amount to $40,000 a year and include four to five carloads of paper towels and 2,500 gallons of cleaning soap.

The M.I.T. telephone system is larger than that of the average community in the Commonwealth. It is the largest private telephone system in New England.

The activity in Kresge Auditorium has far exceeded anyone's expectations before it was built. Last year 1,225 events took place in the Main Auditorium, Little Theater, and Rehearsal Rooms. In the M.I.T. Chapel another 1,180 events took place.

The total mail handled at the Institute probably exceeds the equivalent of a city of 25,000 – cities perhaps the size of Belmont, Melrose, or Gloucester.

In closing, Mr. Stoddard mentioned some of the plans that are being discussed which will affect M.I.T.'s future campus: married student housing; student union building; graduate center; new undergraduate dormitories; materials research laboratory, and so on.

In a talk illustrated with Kodachrome slides and motion pictures, Professor Grant spoke of the trip which he and John Chipman, Head of the Department of Metallurgy, made last summer. They spent nearly a month in Russia as guests of the Russian Academy of Science, as participants in the Moscow Conference on the Physical Chemistry of Steelmaking. They took the opportunity to visit three Russian technical universities, three research institutions, and four steel plants, including three in Siberia. Throughout the trip they had complete freedom to take photographs and movies.

Dr. Grant emphasized the prestige of the scientist and engineer in Russia and the many other incentives that attract into these fields the finest talent throughout the country. He was tremendously impressed by the teaching, research, and the practical work programs that prepare their engineering graduates to step directly into valuable roles in industry. (Last year Russia graduated eight times as many metallurgists as did the United States.)

The large steel mills he visited were modern with good equipment. Certain of their production processes were on a par with those of this country, some behind, and in some cases their applications were 10 years ahead of American mills. There was, on all sides, proof that where the Russians want to put their effort and resources they do; they do it well and with remarkable effectiveness.

Earlier in the evening Horatio L. Bond, '23, chairman of the Audit and Budget Committee, presented his committee's report for the accounts of the Alumni Association for the fiscal year which ended June 30, 1957.

As Secretary for the Association, Donald P. Severance, '38, reported on the November 18 Silver Stein Dinner of the M.I.T. Club of New York, announced that 15 visits had been made to local M.I.T. clubs by 12 members of the Institute and Association staffs, announced changes in class affiliation for three Alumni, and reported new additions to the Council membership.

As Director of the Alumni Fund, Henry B. Kane, '24, reported that, as of November 22, a total of $123,000 had been contributed to the Fund by 4,683 Alumni. Regional solicitations will be made in 140 areas, as compared with 73 regions last year.

The Midwinter Meeting of the Association is to be held on February 4, and Vincent T. Estabrook, '36, chairman of the committee, reported that this year's program will be devoted to the work of the Physical Science Study Committee. The program will necessitate several changes in the form of the meeting. Dinner will be at Walker Memorial, as usual, but will start at 5:30 P.M.; the program itself will begin at 7:30 P.M. in Kresge Auditorium. Various experiments will be set up in the lobby of Kresge to be viewed between completion of dinner and the starting of the Kresge program.

Twenty-five Years Ago This Month . . .

■ With 416 present, on February 4, 1933, at the Hotel Statler there took place the 58th Annual Alumni Dinner, at $2.50 per plate! "It was," said The Review's account, "a carefully planned dinner and the program was happily conceived. As the 39th President of the Alumni Association, Dr. Allan Winter Rowe, '01, presided. His great gifts as a speaker were amply exemplified by the grace, dignity, and deftness with which he conducted the program."

As speakers Dr. Rowe presented Dr. Walter B. Cannon, Professor of Physiology at the Harvard Medical School; Sir Willmott H. Lewis, Washington correspondent of the London *Times;* and President K. T. Compton of the Institute. Dr. Compton's remarks were in part as follows:

"In these times of social uncertainty and economic difficulty our Institute has an unprecedently strategic opportunity for service of a most fundamental value to society. Its object is to impart that knowledge, train that judgment, and develop that social outlook which combine to produce constructive accomplishment, wise leadership, and effective cooperation in this 'scientific age.'

"Since this is a scientific age it is reasonable to suppose that men who have a real working knowledge of science and its applications should be peculiarly well fitted to deal with its problems. This should be especially true where the logic of science is joined with the practical accomplishment of engineering and the creative imagination of architecture, all with due reference to principles of economics. This combination is found in our curriculum, which may be thought of as our platform for world service. Granted this platform, and its proven effectiveness, what can we do still more effectively to produce men who will accomplish, lead, and coöperate?

"Consider first our curriculum. All with one accord are ready to admit that it is a stiff one. That is all right. It is also true that its set requirements leave but little time free for study or thought on the initiative of the student himself. That is not so satisfactory. In the third and fourth years the student may have to take as many as 11 subjects simultaneously. That is certainly undesirable, for it leaves little time for digestion and orientation. It emphasizes the contrast between college, where his work and thought are planned in meticulous detail by the curriculum, and after life where he must plan and steer his own course.

"On accepted pedagogical principles, it would seem wiser to allow the student progressively more responsibility and initiative as he advances toward graduation, so that he may pass easily from college to professional life, having acquired ability to exercise judgment in control of his actions, and habits of independent study, as well as the habits of industry and the knowledge and skill which are developed by our present curriculum. I am pleased to report that a special committee of the Faculty, appointed to investigate possibilities of improving our upper class curriculum, is now working on a plan of revision of the curriculum. . . ."

Boston Herald

The 1,000,000-volt model of the recently developed Van de Graaff generator being demonstrated at the 58th Annual Dinner of the Alumni Association, held at the Hotel Statler, on February 4, 1933.

Grant for Study of India

■ The Center for International Studies at the Institute has received a grant of $750,000 from the Ford Foundation for a program of applied research on social and economic development in India, it was announced at the end of 1957. According to Max F. Millikan, Director of the M.I.T. Center, "the program will concentrate on critical problems related to the economic growth of India. It will attempt to collect the data and make the analyses on which effective development planning must be based."

The proposal for the research was made jointly by the M.I.T. Center and four of India's leading research institutions which will co-operate in the program. The Indian institutions are: the Delhi School of Economics, the Indian Statistical Institute, the Gokhale Institute of Politics and Economics, and the National Council of Applied Economic Research.

Examples of some of the kinds of research the joint India-M.I.T. program will undertake, according to Dr. Millikan, might include analyses of the regional pattern of investment and income change in India, the economic interchange among India's widely different sections, the right kinds of choices of technology for investment in particular sections, and the relations between the growth of big business and small business.

To carry out the new project the M.I.T. Center will maintain in India a rotating team of three or four United States and other experts to work with the Indian institutions over a four-year period. The Center will also bring to M.I.T. a number of Indian scholars to work in Cambridge with experts studying development problems both in India and in other underdeveloped countries. "While the India study will focus on economic problems," said Dr. Millikan, "non-economic problems will also be considered whenever they are relevant to economic ones."

M.I.T.'s Center for International Studies has already been engaged for the past four years on a program of research on Indian economic growth. This program has been part of a broad study of development problems in various parts of the world which has been carried out by the Center with support from the Ford Foundation.

Bind up the Wounds

■ Pain is as much psychological as physiological. This fact has been demonstrated by a discussion appearing on the pages of this periodical ("Ouch!" Technology Review, April, 1954, pages 292-293) reviewing evidence to show that, in many instances, human beings gain dramatic relief from excruciating pain upon being given, by mouth or by injection, an inert substance they are told is an opiate. Hence it is especially difficult for pharmacologists to evaluate accurately the pain-relieving value of new drugs developed for this purpose.

Further proof of the extraordinarily subjective nature of pain comes from recently published studies that compared pain suffered by soldiers from war wounds with pain suffered by civilians as a result of surgical wounds. These studies were made because it has long been a matter of general observation by military surgeons that wounded soldiers may remain calm and placid, not go into shock, and decline narcotics, while suffering from degrees of injury that in a civilian situation would usually prostrate and confuse the victim, and make him clamor for medical relief for his pain.

Three hundred injured men, half soldiers and half civilians, were observed in the course of this study. Efforts were made to have the two groups comparable in essential respects, and to make sure that differences such as age and history of previous illness did not affect the results. The soldiers were questioned (mostly on the Anzio Beachhead) soon after they suffered severe war wounds; the civilians soon after they had undergone extensive surgery. In one third of each group, the injury had been to the bones, in a third to organs of the chest, and in the remaining third to organs of the abdomen.

The subjects, who were all alert and rational, were asked whether they were in pain. If they answered "yes," they were asked if the pain was slight, moderate, or severe, and if they would like something to relieve it. Such medication was desired by 83 per cent of the civilians, but by only 32 per cent of the soldiers! This difference appears even more striking when it is remembered that the civilians had been pampered with all of the resources of modern hospitals, whereas the soldiers had usually been jolted in ambulances over the rough terrain of a battle area, those with bone injuries usually imperfectly splinted. Also, the degree of injury from surgical procedures is usually much less severe than that from wounds inflicted by high explosive shell fragments.

Why this difference? Apparently it arises from the different *significance* of injury to the soldiers as compared with the civilians. A civilian undergoing major surgery, or injured in an accident, feels that disaster has descended upon him. He is being cut off, at least temporarily, from home and family; he must spend days of idleness and boredom in the hospital; his income may be suspended, perhaps permanently endangered. His outlook is one of tragedy; he experiences excruciating pain.

To the soldier, injury is a *reprieve* from disaster. On the battlefield, he has been under constant threat of death. Now, he is being removed from the line of fire; he knows he may never return to battle. His wound is a ticket to survival; therefore, it often gives him little pain even though grave in extent and nature. It should be noted that the Anzio soldiers did not exhibit a general dulling of the pain sensation. They were observed to protest vigorously if their dressings were roughly handled or if they were given an injection clumsily — this in men who did not complain of grievous bodily wounds.

These observations provide statistically validated support of previous conclusions that, in the human being, anxiety level is an important factor in the production of pain. Thus the psychological nature of the pain sensation is underlined, and the difficulty of objective evaluation of pain-relieving drugs is pointed up. A practical medical conclusion drawn by the authors of this study is their urging of doctors not to give powerful opiates routinely to injured patients, without first trying to find out whether the individual in hand needs such medication.

Big Stick Policy

■ Doubtless the first weapon used by primitive man was a limb torn from a tree; is it not extraordinary then that, in this day of sophisticated warfare, clubs are still commonly employed for defense and offense! These are the bludgeons that are standard equipment of civilian police, military police, and navy shore patrols. To be sure, clubs are not the only primitive combat technique police find it expedient to employ. In the army, cavalry became obsolete long ago, but policemen mounted on horses will apparently always be with us because of their unique capabilities in certain assignments, such as the handling of crowds.

Police clubs are of two types, the billet (pronounced "billy") and the night stick. The billet is a pocket weapon, for daytime use. It is about nine inches long and an inch and a quarter in diameter, and weighs a half pound. The billet is carried in a special deep, narrow pocket set low on the leg of the policeman's trousers. Traditionally billets were ornately turned from beautifully grained, highly polished cocobolo or lignum vitae wood, but in today's mass production era they are often molded from rubber, weighted with lead. The rubber billets are not only much cheaper but also have the advantage of doing less permanent damage when applied to the cranium of recalcitrant wrongdoers.

When the policeman goes on night duty, he leaves his billet at the station house, placing a flashlight in its stead in the special trouser pocket, and grasping his trusty night stick firmly in hand. Night sticks, like billets, have in recent decades left romance behind and become purely utilitarian. They were once made, with much decorative turning, from close-grained locust wood, but are now usually strictly functional, plain cylinders of hickory, with corrugated grip and drilled hole for a thong at one end; they measure about two feet long and one and a quarter inches in diameter, and weigh the same as the compact billet.

The leather thong with which night sticks are equipped makes possible the picturesque display of night-stick twirling. Although infinite in its variations, twirling consists basically in grasping the stick by the wrong end, then dropping it while the thong is held firmly. Properly executed, this maneuver causes the stick to spin, then return to the hand which seizes it, much in the manner of a Yo-yo top. Twirling is not included in the curriculum of police academies, but is passed from one generation of cops to the next by emulation. It is a necessary skill for every police officer, as it helps him cope with the main hazard of his calling, boredom.

Although billets and night sticks weigh about the same, the greater length of the night stick makes it a more effective weapon. That is why it is employed during the hours of darkness, when the crime rate rises. The leverage provided by the night stick makes its blows more telling, and the length of the stick enables the policeman to keep his adversary at a distance. The night stick is a versatile weapon, by no means limited to the clouting of a malefactor over the head. Police cadets learn how to disarm an opponent with a blow to the forearm, and also master subtle variations of stick work such as a rap on the shin or a straight jab of the end of the club into the adversary's solar plexus.

But much of the effectiveness of the night stick is psychological rather than physical. Just as scepter and ceremonial mace are symbols of authority, the policeman's truncheon is a poignant reminder to any potential wrongdoer that all transgressions may summarily result in a painful impact of hickory upon flesh. Hence a pacifying measure found to be most potent in times of civil stress and tension, such as strikes and mass demonstrations, is simply to send policemen forth on daytime duty armed with night sticks. Law-enforcement agencies, contending with crime waves, can afford to speak softly when backed by the big-stick policy.

New and powerful radar equipment recently perfected at the Institute's Lincoln Laboratory in Lexington, Mass., greatly extends the range of earlier warning and detecting systems. The new radar installation at Millstone Hill, Westford, Mass., has been used to receive signals from earth satellites. Shown here is William C. McLaughlin, '51, staff member of the Lincoln Laboratory, measuring and recording signals from Sputnik I on both 20 and 40 megacycles per second, simultaneously.

M.I.T. Photo

Athletic Résumé

■ The Institute, as is true of most first-rate schools of technology, has an active academic program with laboratory and other afternoon courses as part of normal operations. Athletics is regarded as a means for developing the student's physical fitness rather than for developing star performers. Fortunately, M.I.T. has no large stadium, nor has it a varsity football team. Within its intended sphere of activity, however, the students have a good time as they become accustomed to alternating physical exercises with mental effort.

Résumés of the last year's activities – with special emphasis on competitions during the spring term – have been prepared by: Robert M. Whitelaw, Varsity Baseball Coach; Frank S. DuBois, Jr., Crew Coach; John H. Burke, Varsity Golf Coach; Benjamin R. Martin, Jr., Varsity Lacrosse Coach; Charles Batterman, Freshman Lacrosse Coach; Edward A. Crocker, Varsity Tennis Coach; David Redhed, Freshman Tennis Coach; and Oscar Hedlund, Varsity Track Coach.

Their résumés of the season's athletic activities, prepared especially for The Review through the cooperation of Richard L. Balch, Director of Athletics, give an over-all picture of last year's freshman and varsity sports at M.I.T.

Baseball

The baseball team's won- and loss-record fell to an all-time low last spring when M.I.T. won one game and lost 17, but, in an optimistic prediction, the future looks brighter.

The southern baseball trip was highlighted by the 3–2 loss to Howard University and the opportunity to bounce foul balls onto President Eisenhower's front-lawn golf course. (The Howard baseball field was situated back to back to the White House.)

Seniors Charles F. Speer, Jr., '57, Martin M. Bressler, '57 (who pitched a one-hitter against Coast Guard for Tech's only victory), co-captains Alvin Richman, '57, and L. Peter Hohorst, '57 (recipient of the annual Clifford Award), provided the backbone of the team. Promising sophomores were: Warren H. Goodnow, '59, Richard J. Campbell, '59, D. Larry Jones, '59, Walter J. Humann, '59, Richard C. Lyons, '59, Jerry D. Welch, '59, and Albert L. Beard, '59. Robert W. Witte, '58, a transfer student from Middlebury College, will captain the 1958 team.

After the season's play, the constructive suggestion from an unidentified source came that Herb Score, Cleveland Indian's pitching ace, could be purchased for a million dollars. The baseball team's motto: "Wait 'till next year."

Crew

The varsity heavyweight crew had a strong beginning and looked promising during its first race on the Charles River on April 27 against Harvard, Syracuse, and Boston University. On June 11 and 15, respectively, M.I.T. raced Dartmouth at Hanover and beat them both times. The first race was over the Henley distance and the second over a four-mile course. However, on June 22 at the Intercollegiate Rowing Association Regatta, unknown difficulties set in, although the shell was rowed gallantly, and M.I.T. was beaten by Dartmouth, finishing eighth in the race.

The freshman crew of the 1956–1957 season perhaps best illustrates the thought that slow starters can sometimes turn out better in the end. The squad worked hard and willingly throughout the year and showed a fine improvement with each contest. They completed their season on June 22 at the I.R.A. Regatta (Syracuse, N.Y.) where in a field of 11 crews they placed second to the Naval Academy Plebe Crew by 3.2 seconds or three-quarters of a length.

The season commenced in September, 1956, with approximately 125 inexperienced candidates (light and heavy). Through the ensuing eight months of the school year, they logged approximately 1,000 miles on the water, 800 of these in the period between February 22 and June 22.

In their earlier races of the spring term, the squad showed much room for improvement, but always maintained their fine spirit of co-operation and zest to do better. As the season progressed, they began to show more and more that they were a team to be reckoned with. At the Eastern Association of Rowing Colleges Sprint Championships (Princeton, N.J.) May 18, they rowed second by a length behind top-seeded Yale in their preliminary heat and finished second to Syracuse in the Consolation Final later that day. This was equivalent to placing sixth (out of 11) in that regatta.

Their finest improvement came after the end of classes (May 30–June 22) when they spent three weeks of double practice in Cambridge, Hanover, N.H., and Syracuse, N.Y., respectively. Their fine accomplishment in placing second at Syracuse was short of their ultimate goal, but was truly deserved in full light of their own fine spirit and teamwork over the many miles preceding that race, which was held in New York state.

Golf

The Tech golf team had a more successful season than is shown by their record of two wins and seven games lost. They lost to Wesleyan 3–4, Brown 3–4, Tufts 3–4, Harvard 2–5, Boston College 3–4, Holy Cross 2–5, and New Hampshire 2–5. They won over Babson 4–3 and Bowdoin 5½–1½.

In the New Englands, M.I.T. tied for eighth in the team totals. Robert L. Rosenfeld, '59, was the only team member and only Greater Boston collegian to qualify and he lost in the first round, one up. Bob was elected captain for the 1958 season. Not only is he a fine golfer but an excellent student as well. He played in the third position most of the season but in the last match with New Hampshire played number one position and fired a 74 medal while winning 5 and 4.

Matthew T. Mulkern, '57, played the first position most of the season and, in meeting the best of the opposition, more than held his own. Matt missed by one stroke of qualifying in the New Englands. Matt, who is the only local boy, comes from Watertown. T. Jerry Carter, Jr., '57, held down the number two slot and had a 3–5 record individually (he did not play against Babson). He is a transfer from Amherst

(Continued on page 220)

Universities-

A KEY TO AMERICA'S LEADERSHIP

Through some manner of alchemy, at all levels of society, we must cultivate a taste for learning, for scholarship, and for all that is excellent both in mind and in spirit

by J. A. STRATTON

THE great overriding question that presses today upon every thoughtful American is our capacity for technological supremacy. For a generation past no one has, for a moment, doubted but that this supremacy was ours without challenge. Suddenly events have transpired that seem to have shaken our confidence. The Russians have scored a superb technological and psychological advantage. In response, the floodgates of our press have opened to pour out a spate of words – words of explanation, of excuse, too often of recrimination. Perhaps a paragraph in Roger Burlingame's recent book *The American Conscience** sums it up as well as any. Speaking of Americans today, he says:

"We are prosperous. We are complacent . . . Skill is anonymous . . . Security has replaced adventure as a dominant aim. Intellect is in the discard."

But I, for my part, must be numbered among those who are reluctant to believe that we have already lost the race for technological leadership or that it is impossible for us to attain it in the future. We retain enormous advantages – advantages in productivity, in capital assets, and in scientific resources which we need only exploit.

But time is of the essence. These foreign objects sailing over our heads have galvanized the attention of the American people at last to the great and immediate tasks ahead. We must put an end to the finger-pointing and recrimination and go to work; for the fact is that we have all been at fault and there is no quick cure for our trouble.

Perhaps our greatest risk at the moment is to believe that we may purge ourselves by words or that we shall fall back upon temporary expedients. A small change in our budget, the reports of a few congressional investigating committees, a few key appointments, however important, will not suffice to re-establish our position. Let me say by example that, to my mind, one of the truly constructive steps accomplished lately has been the appointment of Dr. Killian as Special Assistant for Science and Technology to the President of the United States. No one can know better than I, who have worked with him so intimately over the years, how superbly qualified he is for the formidable task before him. And yet I am appalled by the willingness of many to believe that one man alone, be he adviser or czar, can remedy the scientific ills of this country.

Let us take stock of our position. To most people the idea that Russia could overtake the West seemed fantastic. How could a country, starting only a short time ago with such severe handicaps, be in a position to challenge us with our own methods and our own weapons? How could her scientists, working under the shadow of a ruthlessly enforced ideology, be a match for those of a democracy?

If we are to understand Russia's advance, we must accept certain basic facts. First, we must recognize that the successful launchings of the satellites were more than brilliant, isolated triumphs of Soviet science engineered by "crash programs." They were the logical and predictable products of a great and sustained effort in education and scientific research that reaches to the very roots of Russian culture. From the start, the cultivation of science and technical advancement have been at the heart of the Communist program.

This policy goes back to the days of Lenin. Stalin was willing to pay any price for industrial and technological achievement. The cost was enormous but he got results. It was only in the latter part of his regime that political ideology began to interfere with the development of science. And the key fields of physics, astrodynamics, chemistry, and higher mathematics have been singularly free from political influence.

Fortunately we seem to be well past the point of seeking comfort in the belief that Russian education is so doctrinaire as to be worthless or even second-rate. We are challenged by a powerful movement – an educational movement widely supported by an entire people and surging forward with gathering momentum. Whether or not we are momentarily ahead or behind, in one field or another, is now of very little consequence. Our concern must be focused on the ominous change in the Russian potential.

To recognize that the Russian people are possessed by certain dreams and moved by national aspirations implies no sympathy for their method or system. But we must coldly evaluate the strength and resources of our competitor. It is difficult to foresee whether they will rely ultimately on military force or whether they will endeavor to overwhelm us with a techno-

*New York: Alfred A. Knopf, 1957.

M.I.T. Photo
A group of M.I.T. students attend class in the Great Court. Of late, the most gifted of our faculties are in danger of losing touch with undergraduate education in the colleges, and have signally failed to support the dignity and importance of the high school teacher.

logical supremacy. One thing, however, is absolutely clear: they are convinced that the key to all future power, of whatever kind, lies in science. Unless we are prepared to cope with that challenge, it is futile to wish for our continued technological leadership.

There is now a point that I should like to stress to you — an idea that seems to me even *more* important. Our preoccupation with science these past few weeks has been centered quite understandably on the immediate threat to our external security. And yet, if by some magic this threat of war should disappear — indeed if there were no Russians at all — the lesson of the satellite is clear. The world has crossed a certain critical threshold in the realm of science, and like a nuclear chain reaction the advance of science is now feeding upon itself and moving forward at an ever-accelerating pace. Each new discovery in pure science brings with it its multitude of applications for new products, new services, and new industries. These are changing not only the economic structure of the globe, but the entire character of our civilization.

For a long time past, in technological matters, we Americans have been the most knowing and sophisticated people of the world, and yet it seems to me we are now failing to comprehend the degree to which the forces of science and engineering are about to dominate the lives of succeeding generations. Wholly apart from the imminent danger to our physical security, our capacity to maintain our economic and cultural superiority in the face of rising competition rests upon the fruitfulness of our research and, even more importantly, our capacity to live in harmony will be measured by our skill in fusing both science and humanities into the common culture of our people.

I have the faith and confidence in the American plan of life to believe that we can meet the challenge, although at a cost and a sacrifice. In the present mood of self-criticism, the American system of education has been drawing the hottest fire. As President Eisenhower has stated, "We have failed to give high enough priority to science education and to the place of science in our national life."

To remedy this situation there are certain obvious and immediate steps to be taken. We all know quite well what these are: we must pay more to our teachers; we must find ways of encouraging boys and girls to study science, and of inducing men and women to teach them. And because the mass of students is about to increase enormously, we had better look hard at the teaching process itself to see if we cannot make it more effective and appealing. All this has been said over and over again, and these are measures that press upon us most urgently. But let us clearly recognize that these are emergency measures only. The small pay and the meager prestige of the high school teacher is only symptomatic of much deeper ills. There is little to gain by shifting the blame onto local school boards, for the ultimate responsibility lies within the family and within the community. The quality and character of the nation's schools only reflect the basic attitudes of American society toward education and learning. The support that we give to our local schools is the measure of our cultural aspirations.

The searching question now is whether the American public has been stirred deeply enough to leave a lasting impression. It must come to realize the transcendent importance of science in the modern world, and it must be freed from the conviction that science is wholly materialistic and vocational, that it undercuts the dignity and individuality of man, that it contributes only to the convenience and not the quality of our society.

The mistrust and even hostility so frequently encountered in the lay public as to the nature of science comes from our failure to make science an integral part of our common education. A recent poll of American high school students conducted by Professor H. H. Remmers of Purdue University found that 45 per cent of them thought that their school background was too poor to permit them to consider science as a career, 30 per cent believed one cannot raise a normal family and be a scientist, 25 per cent thought scientists were "odd," and 14 per cent thought they were evil.

It is such evidence that leads me to believe that a re-examination of the aims and purposes of a liberal education in a modern context is by far our most urgent need. There is indeed today a serious shortage of scientists and engineers. We must do what we can to swell their ranks, but great scientists, great engineers, and great educators will come most readily from a society in which educated men and women are as at home in the sciences as they are in the humanities.

In the simplest possible words, I do not believe that the principal function of our secondary schools is merely to produce more scientists or future engineers. On the contrary, it must be their aim to develop an educated public competent to deal with the human and technological problems which will grow ever more complex.

And there must be changes in attitude even more important than changes of substance and curriculum. We in America have been curiously plagued by the fear of an intellectual elite. We have tended to distrust intellectual achievements that are not to be had by everyone on equal terms. There has been too little pride and understanding among Americans of the quality of excellence.

Through some manner of alchemy at all levels of society, there must be a cultivation of a taste for learning, for scholarship, and for all that is excellent in mind and spirit. We must take better account of the wide spectrum of human abilities, interest, and initiative, while at the same time maintaining the facilities and opportunities to every American child for education.

Again, the schools must help, but the basic responsibility for this reorientation of attitude rests with the family and the community. Without this support, without our active participation as citizens and as parents, the schools can never hope to accomplish the task that now lies before them.

The schools, then – and I am speaking particularly now of our primary and secondary schools – must be supported from below. But they must also be supported from above. There are 40,000,000 Americans – nearly one out of every four people in the nation – going to school today. We rely upon these schools to mold American ideals and to develop American talent. And at the top of the system are the colleges and the universities. Increasingly we depend upon these institutions of higher learning for graduate work and research.

But let us not forget that the traditional function of the university is to teach and to provide teachers as well as to advance learning. It has seemed to me of late that the most gifted of our faculties are in danger of losing touch with undergraduate education in the colleges themselves, and have signally failed to support the dignity and importance of the high school teacher. In this time of crisis it is incumbent upon the university professor to prove himself the most powerful ally of the secondary school.

I think it important, too, that the faculties of our great professional schools should devote attention to the needs of the modern curriculum and modern methods of teaching comparable to their efforts in scientific research. Indeed research in teaching may be at the moment our greatest need.

It gives me great pride that the Institute has begun to recognize its obligation toward the teaching of science at every level in our schools. The Physical Science Study Committee, which has been hard at work at the Institute for more than a year has, as its specific aims: "(1) to plan a course of study in which major developments in physics, up to the present time, are presented in a logical and integrated whole; (2) to present physics as an intellectual and cultural pursuit which is part of present-day human activity and achievement; and (3) to assist physics teachers, by means of various teaching aids, to carry out the proposed program." This committee has enlisted the active support of teachers from all parts of the country in planning an improved high school physics curriculum. Already several films and a new high school physics textbook have been prepared, and more aids to teaching at the secondary school level are on the way. To my mind, the project is a wonderfully imaginative, brilliant effort on the part of a

(*Concluded on page 214*)

Charles E. Brown

Invention in Flight

Great possibilities lie ahead for the congregation of nations best able to reap the benefits of its men of talent

by J. L. B. BLIZARD

"It took man about 25,000 years to decide to fly. Thereafter, it took man only 50 years to surpass the birds in their own realm." — Jacqueline Cochran.

How did man achieve flight? Was it a sudden inspiration, or a gradual development? Was there a single invention which made man air-borne? Actually man achieved flight by several alternate means — balloons, gliders, dirigibles, and propeller, jet, and rocket airplanes. Several of these vehicles could and did evolve independently.

The helicopter showed the earliest promise of developing into reality. Over 450 years ago, da Vinci designed an "aerial screw," a helicopter-like device powered by a spring motor. However, after such a precocious beginning, the helicopter's development was severely retarded. Da Vinci's idea was completely lost to the world for 300 years, and his complete works were not published until 1930.

Meanwhile, air progress continued along other lines. In 1783 the Montgolfiers launched the hot-air balloon, the first apparatus for high-altitude research.

Gliders were then developed by Lilienthal in Germany, Pilcher in England, and Chanute in America. Although none of these was a powered craft, valuable aerodynamic information was obtained which later contributed to the airplane.

The dirigible was developed to a high state in Germany. It saw long years of passenger and mail service before the flaming disaster of the *Hindenburg* in 1937 put an abrupt end to its history.

The most promising of all lines of development culminated in the Wright brothers' airplane. After their first successful flight in 1903, the propeller airplane developed quickly into the many versions we know today.

But what of the helicopter? Although a manned helicopter flight was made as early as 1907, further advance did not come until 1923 with the development of the autogiro by a Spanish engineer, Juan de la Cierva. The first practical helicopter was put into flight by Igor Sikorsky in 1939. And the helicopter did not see war duty until the Korean conflict (1951-1952), 35 years after the first mass war use of propeller airplanes. With a free flow of communication, the helicopter's history might have been very different.

Although all of the above-mentioned aircraft place man in the realm of the air, each achieves flight by a different means and has a different range of application. For an obvious example, the velocities available with various aircraft distinguish sharply between gliders, dirigibles, and helicopters on the one hand, and propeller, jet, and rocket airplanes on the other. But the high speed of jet and rocket airplanes is achieved at the expense of high-fuel consumption per mile (Table 1). And the slow helicopter achieves a maneuverability which is impossible for the faster aircraft. Modern technology can design an air-borne vehicle to satisfy almost any specification, or even several specifications, but not all desirable characteristics can be built into a single craft.

Flight in Nature

Eons before man ever thought of flight, nature wrestled with the problem and evolved at least three distinct answers for a variety of conditions and materials: birds, bats, and insects. (A fourth extinct reptilian group might also be included here.) Even within

TABLE 1

1	2	3	4	5	6	7
Type of Aircraft	*Use*	*Speed Range (MPH)*	*Cruising Speed* (MPH)*	*Fuel Load for Col. 4*	*Advantages*	*Disadvantages*
Dirigible	Short and long range transport	0-100	50		Independent of weather conditions	Low speed, lack of maneuverability
Helicopter	Rescue, Evacuation short range transport	0-200	100	11,300 lb	Maneuverability, vertical take-off and landing	Low speed
Piston Engine	Long range moderate speed transports, bombers, fighters	0-350	300	5,650 lb	Low fuel consumption, reliability, long life	Operates at relatively low altitudes
Turbo-prop	Long range bombers and transports of high take-off weight	0-Sonic (600-900)	500		High power, low fuel consumption for heavy loads at take-off. Long range	Limited in speed only by current propeller efficiencies
Prop-jet	Longer range than Turbo-jet		440	10,300 lb	Moderately high speed and high performance at high altitude	Limited in range by fuel consumption
Turbo-jet	High-speed medium-range fighters, small bombers, possibly transports	0-Sonic	560	24,000 lb	High speed, relatively high altitude. Smooth performance	Low thrust, at low speeds and altitudes. Payload and range limited by fuel consumption
Pulse Jet	Missiles, perhaps some aircraft	0-1,500	325 (V-1)		Simple design, cheap to manufacture, expendable	Extremely high fuel consumption, vibration, noise
Ram Jet	Pilotless aircraft, guided missiles	800-2,600	750	11,500 lb exclusive of auxiliary power plant	Extremely simple design, capable of great speed	Requires auxiliary power plant to reach operating speed
Rocket	Missiles, high-speed intercepter aircraft. (Space flight)	0-3,500	1,000	990,000 lb†	Extremely high speed able to operate outside atmosphere	Very high fuel consumption

* For 1,000 mile range, 40 passengers

† Estimated

a distinct category, a wide variety developed to meet differing conditions (Table 2).

Birds, as well as airplanes, are designed for a great number of environmental conditions. The sea birds have long, narrow wings designed for hours of uninterrupted gliding. Hawks glide also, but their aerodynamic characteristics are tailored for dive-bombing. The highest recorded speed of any bird, 200 miles per hour, has been noted in a duck hawk's dive.

Hummingbirds, the avian helicopters, are capable of sustained hovering – forward, backward, and up-and-down motion. This maneuverability is bought at the price of a small size and high metabolism – sustained by the highest rate of wingbeat and heartbeat known among birds.*[1] It is interesting that the energy consumption of hummingbirds (726 B.T.U./lb./hr.) and helicopters (750 B.T.U./lb./hr.) is remarkably similar.[1]

Early creatures underwent severe modifications in order to fly. The entire anatomy and physiology of the bird is subordinated to the requirements of flight. Weight has been cut down in the feet, legs, and head, and powerful wing muscles have been developed. In some birds, the reproductive system during most of the year shrivels to 1/1,500 of its weight during breeding season.[2] The power/weight ratio of birds has been increased by special adaptations, including hollow bones, feathers, and a high metabolism maintained by pulse rates up to 600 per minute and body temperatures up to 113 degrees F. The frigate bird has a wing span of seven feet, but its skeleton weighs only four ounces. This is less than the weight of its feathers.[2] The diet of birds consists only of high-calorie foods (high-octane fuel), and birds utilize a greater proportion of the food they eat than do mammals. A young stork gains a third of a pound of weight for each pound of food – a 33 per cent utilization of food compared with about 10 per cent in young mammals.[2]

*[1]Please see numbered references at end of article page 218.

Flight by Man

Just as birds required special adaptations to become air-borne, man needed certain modifications for flight. In order to fly, man had to achieve a higher

TABLE 2

CHARACTERISTICS OF BIRDS

	Low	*Typical*	*Maximum*
Range	20 miles Grouse	200 miles Robin	3,000 miles nonstop Golden Plover
Cruising Speed	5 mi/hr Woodcock	35 mi/hr Robin	180 mi/hr Swift
Power	112 ft-lb/min (full flight) Pigeon	500 ft-lb/min (take-off) Pigeon	1,085 ft-lb/min (hovering) Pigeon
Wingspan	4.5 inches Hummingbird	8 inches Robin	11.3 feet Albatross
Wing Area per gm wt	0.5 cm^2/gm Loon	4.2 cm^2/gm Hummingbird	9.5 cm^2/gm Leach's Petrel
Weight	0.1 ounce Hummingbird	3 ounces Robin	25 pounds Pelican
Take-off Characteristics	Must plunge from cliff; Puffin, Gannet	Requires runway and headwind; Condor	Vertical take-off Quail
Aspect Ratio $\left(\frac{\text{wing length}}{\text{wing width}}\right)$	3/2 Grouse	3/1 Crow	11/1 Albatross
Gliding Angle	9 ft/1 ft Pigeon	16 ft/1 ft Eagle	24 ft/1 ft Gull
Wing Beats/sec	8/sec Pigeon	12/sec Swift	55/sec-hovering 75/sec-flying 200/sec-diving Hummingbird
Body Temperature	105 degrees F. Pigeon	107 degrees F. Sparrow	113 degrees F. Thrush
Heart Beats/min	135/min Pigeon	514/min Canary	615/min Hummingbird
Blood Pressure	99 mm. Hg Robin	145 mm Hg Pigeon	180 mm Hg Chicken
Metabolic Turnover	105 min Bluejay	45 min Thrush	27 min Cedar Waxwing

"metabolism" and a lightweight streamlined structure. He accomplished this, of course, not by redesigning himself, but by building himself a cocoon with the proper characteristics.

Although the craving had existed for hundreds of years, flight was not possible for man until the proper combination of materials was available. With the advent of light structural metals, the internal combustion engine, gasoline, and safe-testing methods, the development of aircraft could follow naturally.

Light Structural Metals. Most early airplanes were built of paper, cloth, and wood strips, similar to today's model airplanes. One flight test was often enough to finish such a craft, not to mention its pilot. Even as late as 1918 many airplanes had plywood covered wings.

Before aluminum was developed, the lightest strong metal in any abundance was iron, of density 7.9 grams/cubic centimeter. Not until 1886 was a method of separating aluminum developed (independently by Hall, U.S., and Héroult, France). Aluminum, with density of 2.7 grams/cubic centimeter, was already an important structural material for airplanes in World War I. By 1930, American aircraft companies were using 5,000,000 pounds per year. At the time of World War II, magnesium (density 1.7) was becoming available – production increased eightyfold in the five years after 1938.

Lightweight Power Plant. As late as the Nineteenth Century there were only four prime movers available for flight propulsion: steam piston engine, steam reaction engine, skyrocket propulsion, and spring mechanism (clockwork). (The internal combustion engine was not developed until 1887 by Daimler and others.) All of these methods of propulsion were tried at one time or another, without evident success. Da Vinci's helicopter was designed to be powered by a spring motor. The motor might have worked in a model, but would have been too weak for manned craft. About 1500 a Chinese Mandarin, Wan-Hu, made his first and last flight in a kite chair powered by 47 gunpowder rockets.[3] A design for a rocket airplane, powered by guncotton, is ascribed to Siemens in Germany in 1850.[4] It was never built, fortunately for the safety of the persons concerned. Even today most rocket fuels are hazardous to the extreme. While in his cell awaiting execution for the Czar's assassination, Kibaltchitch in 1881 designed a flying platform powered by rocket propulsion.[5] It bears a remarkable resemblance to the modern American "Flying Bedstead," which is jet propelled. The early design might have worked, but could not have kept the vehicle air-borne for more than a few minutes with the rocket fuels then available.

Steam reaction may have been the power plant used by the Greek philosopher Archytas (360 B.C.) who built a mechanical flying bird.[3] A British patent was issued in 1841 to Golightly for a steam reaction airplane, which was never built.[6] In 1842, a functioning model of a steam reaction helicopter was demonstrated by Phillips in Paris. Reports stated that the small helicopter "rose to considerable height and traveled a long distance horizontally until it touched the ground again."[6] As with the spring motor, there was sufficient power for a model airplane but probably not enough for a manned airplane.

In the Nineteenth Century, the steam piston engine was probably the only existing engine with sufficient power for airplane propulsion, but it was far too heavy. A Glasgow engineer, Kaufmann, mounted a steam engine in a flying vehicle, but it never got off

TABLE 3

HEAT VALUE PER POUND OF VARIOUS FUELS

Fuel	*Average B.T.U./lb.*
Wood	5,500
Lignite	6,000
Coal	14,300
Gasoline	19,500
Acetylene	20,100
Methane	21,400
Diborane (B_2H_6)	31,000
Diatomic Hydrogen	51,900

the ground.[7] The American physicist Langley successfully flew a 12-foot model airplane equipped with a small steam engine in 1896.[8] His later experiments with a manned airplane ended disastrously in 1903, just nine days before the Wright brothers' famed flight at Kitty Hawk. However, his airplane was successful in all respects but power plant. In 1914, Glenn H. Curtiss obtained permission to install a modern lightweight gas engine in Langley's aeroplane, and the contraption proved itself capable of sustained flight.[9]

High-Test Fuel. The two major fuels available before the Twentieth Century – wood and coal – were not noted for high efficiency per unit weight (Table 3). Gasoline occupies 50 per cent less space than coal and has 25 per cent less weight for equal heat value. Indeed, it has been suggested that the conventional propeller airplane became possible only upon the availability of petroleum fuels: "The enormous development of aeronautics in our lifetime is a consequence of the availability of gasoline. The Wright brothers' invention at any previous time could have amounted to no more than an improvement in gliders, perhaps of some interest to sportsmen . . . In January of 1900 the world's first great oil gusher was blown in near Beaumont, Texas, spouting an estimated 100,000 barrels a day before it could be brought under control . . . After Spindletop, oil became an industry and opened possibilities for the machine age that brought about rapid changes in Western society."[10]

Gasoline is indispensable to modern aircraft. However, the fact must be faced that gasoline may not always be available. Obviously substitute fuels will be found (or grown, as alcohol), but will the "alcohol" airplanes of the Twenty-first Century resemble our airplanes of today? A difference of fuel alone may change them completely. The change may come soon: Eugene Ayres, former Research Director of Gulf Oil Corporation, states: "We can now forecast reliably that production of oil will begin to decline in the United States in 10 to 15 years and in the rest of the world not very long afterward . . . In short, all the signs indicate we are within sight of the end of the fossil fuel era on our planet."[11]

Safe Testing Methods. The annals of early flight are filled with accounts of fatal accidents. A static means of testing was needed – before piloted attempts were made. More aerodynamic data were needed.

Newton studied the air resistance around spheres by dropping bodies from a height. This method of testing was perfected by the French engineer Eiffel, who performed extensive experiments on his famous tower. Another technique was used by Cayley and Lilienthal – the whirling arm – similar to a merry-go-round. Much reliable low-speed data were obtained by this method, but the turbulence set up after a few revolutions was usually troublesome.

The ultimate instrument for aerodynamic investigations has been the wind tunnel. A simple form of wind tunnel was built as early as 1871 by Wenham for the Aeronautical Society of Great Britain. The extensive tests of the Wright brothers in their homemade wind tunnel may have been the decisive factor in their success.

Differentiation of Aircraft

Just as birds have adapted to a wide variety of environmental conditions by evolving 25,000 species (and flying insects 630,000 species), the aerial ships of today feature a wide variety of special characteristics. Man has designed aircraft for high speed, long range, maneuverability, low-fuel consumption, and so on, but has found it impossible to combine all desirable features in a single vehicle. Thus there is the ram-jet, capable of high speed at relatively high efficiency, but which will not operate until speeds of several hundred miles per hour have been reached! Similarly, high-speed airplanes can be designed to take off from short runways (for example, aircraft carriers) but only if one is willing to pay the high price in fuel of jet-assisted take-off units and thrust augmenters.

Man has broken altitude and speed records successively in the *X-1* and *X-2* rocket airplanes, but the fuel consumption is so fantastically high that the airplane must be carried aloft to 30,000 feet by a con-

(*Continued on page 216*)

Soviet Education

FOR SCIENCE AND TECHNOLOGY

In greatly abbreviated form, but in the author's own words, The Review presents a summary of a comprehensive survey on Russian education in science and technology

by ALEXANDER G. KOROL

That Soviet technologists have been successful in launching an earth satellite – as they promised they would be – points to the high level of scientific progress and technological resources the Kremlin can draw upon to achieve any objective it thinks is sufficiently important. The Soviets have assumed world leadership in at least one field of science; they could do so in other fields as well, for the stakes are high and the winner plays "for keeps."

Concentration of national effort, coupled to first-class technical education, accounts for the present Soviet superiority in rockets. As we ponder our own vexing problems of national effort and educational progress, it is well to take a look at current education in Russia. Under present circumstances, it is imperative for us to examine and to understand the close coupling that exists between Soviet training in science and technology and objectives of the Kremlin.

Fortunately, the Center for International Studies at M.I.T. has just completed a timely and significant contribution in this field in Alexander G. Korol's book, Soviet Education for Science and Technology, *published jointly by The Technology Press of M.I.T. and John Wiley and Sons, Inc., New York. Mr. Korol's comprehensive study of current Russian technical education examines its structure, strengths, weaknesses, and – most important of all – its potentialities as it reflects the objectives and rationale of Soviet communism. Mr. Korol's findings are directly related to current problems of American education, and raise some important questions about the aims of our educational system.*

Mr. Korol's conclusions on Soviet technical education are of particular interest and significance to Review readers. For this reason a few of the more important observations and conclusions of his study are presented on these pages with the approval of the author and publisher. Admittedly, the few selected passages presented here, in the author's own words, cannot hope to present the entire pattern of a fabric woven together in a 500-page volume. It is hoped, however, that enough of the warp and woof is displayed to give a hint of the over-all design, and to show the close relationship between technical education in, and the clearly stated national objective of, the Soviet Union. – Ed.

SOVIET civilian institutions of higher education include two general types: the universities, of which there were thirty-four in 1956, and the institutes – a general category embracing more than 700 schools.

Future Soviet physicists, chemists, and mathematicians receive their undergraduate training only at the universities; in the engineering schools (including the so-called polytechnic institutes) undergraduate physics, chemistry, and mathematics are given only as service courses. But even the universities of the Soviet Union are far more vocationally oriented than their counterparts outside the Soviet bloc. Beginning with 1955, for instance, all university graduates were to be certified as school teachers of their specialty (such as history, Russian language, or physics). The vocational bias of the Soviet university is also clearly reflected in the designations of majors ("specialties") offered at the undergraduate level. . . . Several of the university majors of undergraduate instruction are also offered in a number of specialized schools of higher education generically referred to as institutes.

With a few exceptions, the schools categorized as "institutes" can be identified directly by their names, e.g., Moscow Engineering-Physics Institute. Others, however, are named "academies" (e.g., Leningrad Forestry Engineering Academy), or "*uchilishche*" (e.g., Moscow Higher Technical Uchilishche, i.e., school). Music conservatories are also included in the general category of "institutes." At the undergraduate level the institutes train for all types of employment; correspondingly, they fall into a number of more or less distinct and internally homogeneous groups of institutes such as pedagogical, medical, and arts.

Central control of the education of specialists in the USSR is embodied in "academic plans" established by the Soviet Ministry of Higher Education for all the designated areas of specialization within the authorized fields of professional training. Thus a given academic plan (*uchebnyi plan*) presumably reflects the current judgment of the Ministry as to (1) the kind of training the specialist must have in order to satisfy the needs of the operating (industrial and other) ministries and (2) the most effective use of the available academic resources in the conduct of this training.

The basic structure of Soviet academic plans for professional training – training for a specific job – was first established in the early 1930's; and frequent and numerous changes, especially in curricular details, were made in subsequent years. The most recent and apparently far-reaching campaign calling for fundamental improvements in the entire academic process and involving a very considerable revision of both the university and engineering courses stems from the Party directives of 1954.

By far the most outstanding characteristic shared by all *uchebnyi* plans is the very large proportion of total time allotted to *scheduled*, i.e., compulsory, class attendance. Six scheduled hours per day, 36 hours per week (not counting the time given to military training) appear to be standard, at least for the freshman year, in all Soviet schools:

> In recent years the curricula [*uchebnye plany*] have been so structured as to provide, according to the schedule, 36 hours of required attendance per week in all semesters. Formerly, the plan, which unfortunately remained in effect for only one year, called for a different number of hours . . . [diminishing each year down to 24 hours in the fifth year].

In comparison, the MIT freshman schedule, for instance, calls for about 24 hours of classroom and laboratory attendance, *including* Military Science (3 hours per week).* Thus a Soviet student has approximately 70 per cent more scheduled class hours in his freshman year than his American counterpart at MIT:

	Hours per Year	*Index*
MIT (30 weeks) (24 hours) =	720	100
Soviet (34 weeks) (36 hours) =	1,224	170

If one considers that, on the average, the number of class hours in American universities and colleges is about 20 hours per academic week, the score of the Soviet freshman on required attendance is just about double the American average. Furthermore, 36 scheduled hours per week has not been the maximum in Soviet curricula. The 1953 schedule for the seventh semester in all specialties at the Moscow Steel Institute was reported at 43 required hours per week.

The dominant feature of the communist state is the total control over political, economic, cultural, and social life exercised by a self-appointed and self-perpetuating Communist Party dictatorship. Its educational system, correspondingly, is an instrument

*The normal student schedule at MIT is considered to be 50 hours per week, including class and laboratory attendance *and preparation*.

The largest single school system in the world is under the control of the Communist Party . . . it emphasizes science and technology more than any other educational system . . . and beyond a certain minimum of general education, it concentrates exclusively on specialized training at vocational, sub-professional, and professional levels.

M.I.T. Photo

designed solely to serve Communist Party interests; and the Communist Party dictatorship defines precisely what it wants of its educational system and what kinds of skills it needs at its command at any given time. It has a *proprietary* interest in training its subjects in whatever numbers and at whatever levels and categories of skill are needed for its designs and purposes. Thus two foundation facts of the Soviet educational system are the prescription of *national maximum* admissions quotas and the assurance that all designated vacancies are filled.

The organization and content of Soviet education reflect two dominant objectives: first, to inculcate a complete – and, if possible, devout and enthusiastic – commitment to the will and ways of the Communist Party; and second, to develop maximum technical competence for work in designated occupations and capacities.

The Soviet educational system must always be related to a basic problem of communist dictatorship: if the entire training program is controlled and organized for specific planned uses – as it is in the Soviet Union – can the distribution of trained manpower be left to chance?

As significant as its exercise of power to employ the already available resources of trained manpower in desired directions is the apparent success of the Soviet system in inducing, on the part of the student, self-motivation toward higher education. In terms of status, prestige, and economic advantage there are no desirable alternatives to professional education in the Soviet Union (aside from a purely Party career). Consequently, the aspirations and energies of Soviet youth are automatically directed toward educational goals.

It is plain, then, that central control over the educational system is an inevitable and logical consequence of the Soviet rationale of education. That control explains both the major strengths and the major weaknesses of the system. Among the elements of strength deriving from centralized control – which include the power to enforce decisions, to allocate resources, and to coordinate the component parts of the educational ladder into a system – perhaps the most important from the qualitative standpoint is the mechanism for establishing a minimum standard, at least in a formal way, for schools at every level and of every kind throughout the Soviet Union. But to the extent that the intensification and effectiveness of central control may enhance the positive elements of the system, they also increase its deferred costs and liabilities. Among the negative consequences of centralized control – which include progressively increasing difficulties of accurate planning, a capacity for committing policy blunders all at once on a national scale, and the unprecedented growth of bureaucracy – the most significant is the progressive paralysis of individual initiative which has been spreading through the entire Soviet educational fabric.

What are the Soviet objectives, requirements, and tasks which its educational system and its trained manpower are intended to serve?

The answer is provided by history. In the context of the war long ago declared by communism against the free democratic societies, but still not taken seriously enough by many of the intended victims, the Soviet Union has committed the major part of the productive effort, skill, and talent of its people to the maintenance and increase of communist capability for the aggressive expansion of communist power. It has mobilized a major share of the social and economic resources of the areas it controls to advance its technological means toward achieving this objective. It is this objective which the Soviet educational system is ultimately designed to serve.

But any final evaluation, any attempt to seek ultimate meanings as we return to the inevitable questions which arise when we set the Soviet educational system against our own, brings us back to a single fact. It is the total Soviet government power of control over the allocation of all resources which alone concentrates educational resources in accordance with the government's scale of priorities.

The fact remains that the largest single school system in the world is under the control of the Communist Party, that it emphasizes science and technology more than any other educational system, and that, beyond a certain minimum of general education, it concentrates exclusively on specialized training at vocational, sub-professional, and professional levels.

What does this fact mean to Russia and her annexed neighbors and to the rest of the world? What does it mean to America?

Soviet education has been called a challenge – a defiant invitation to engage in a contest. That it presents a challenge, few observers would deny. But one must be clear as to the direction in which the challenge lies. The conclusions derived from the evidence here examined would suggest that the nature of the Soviet challenge is not expressed in numbers, nor even in quality, but in the degree to which national education and training efforts and performance are consonant with national goals. The essence of the challenge for the United States, therefore, is not to permit the scale, character, flexibility, vigor, and quality of American education to lag behind its expanding goals and responsibilities. These are the criteria by which American education must be judged, not by reference to how many engineers are or are not trained in the Soviet Union.

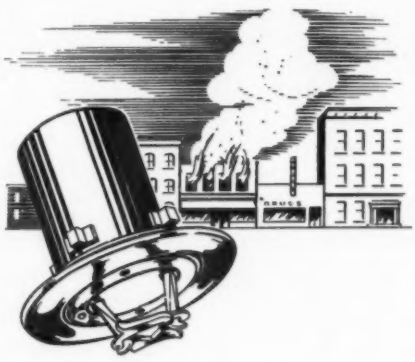
Soviet education has also been called by many justifiably apprehensive American observers a threat. The choice of terms, incongruously linking as it does the word "threat" with "education," is unfortunate, for its implication is false. The locus of the threat is not Soviet education but Soviet communism. For that matter, the threat derives in part from the fact that there is no true education under communism. Soviet education, with its emphasis on specialized training, has been transmuted into a threat to freedom only because Soviet scientific and technological capabilities are mobilized solely for the support and expansion of communist power. It is the employment of the accumulated resources of the Soviet Union and of its satellites to the ends of the Communist Party that constitutes the threat.

(*Continued on page 212*)

BUSINESS IN MOTION

To our Colleagues in American Business . . .

Should a fire break out in many of the modern stores, office buildings and institutions today, the excited cries of "Fire!" "Fire!" "Fire!" will have barely died before the fire is under control. For, located in the ceiling of these structures, and barely visible, are the automatic sprinklers that go into action in case of fire. And mighty important fire watchers they are, too. Although unnoticed and unattended for years, they must be able to go into immediate action, fast, and without fail.



A vital part of this sprinkler is the body. A leading manufacturer of these sprinklers used to make these bodies of cast bronze. But in order to obtain the close tolerances required, the casting had to be excessively machined. Also, in order to assure fool-proof operation after installation, each casting, after machining and prior to assembly, had to be pressure tested. Due to porosity many of the castings failed and the number of rejects became prohibitive.

Engineers of the sprinkler manufacturer consulted with Revere's Technical Advisory Service and as a result Revere was asked to forge the sprinkler body. After extensive testing, the forging of Revere Brass was selected . . . because it was found that closer tolerances with a minimum of machining were possible, elimination of sand holes did away with rejects entirely, pressure testing was no longer necessary and the better appearance of the forging made a more sales-appealing product. On top of this the rate of assembly was nearly doubled by the use of Revere Brass Forgings. Overall savings amounted to more than 20% of the former cost of the sprinkler body.

Here you have still another example of Revere cooperating with the customer in selecting the right metal in the right form to do the best job with the greatest economy . . . be it aluminum, copper or any one of their alloys.

Not only the copper and brass industry but practically every industry you can name is able to cite similar instances. So we suggest that no matter what your suppliers ship you, it would be a good idea to take them into your confidence and see if you cannot make a better product at lower costs by specifying exactly the right materials.

REVERE COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

Executive Offices: **230 Park Avenue, New York 17, N. Y.**

HEVI DUTY

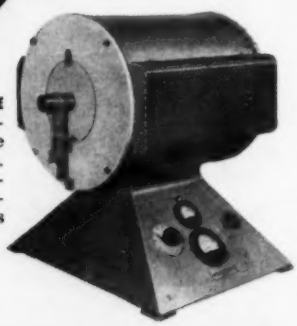
IN STEP
with tomorrow's
stepped-up
DEMANDS

LABORATORY FURNACES

COMBUSTION TUBE FURNACE — Hinged tube furnaces are available in various sizes with temperature ranges to 1800°F or 2200°F.

MUFFLE FURNACE—"Multiple-Unit" Muffle furnaces have a maximum temperature of 1850°F. Temperature indicating and controlling devices are located in the pyramid base for full protection and visibility.

HIGH TEMPERATURE TUBE FURNACE — Temperatures to 2600°F. can be reached in this furnace. Other Hevi-Duty laboratory furnaces have maximum temperatures as high as 3000°F.



HEVI-DUTY ELECTRIC COMPANY

MILWAUKEE 1, WISCONSIN

Harold E. Koch, '22, *President*
Elton E. Staples, '26, *Vice President*
Chester Meyer, '36, *Assistant Secretary*

SOVIET EDUCATION FOR SCIENCE AND TECHNOLOGY

(*Continued from page 210*)

Soviet education has also been viewed as a weapon which will help eventually to destroy the very threat that some observers believe it poses. This view reflects an abiding faith in education as a means of social progress; it derives from the identification of moral values and social goals with educational advances. In the Western democracies this identification is taken for granted. Consciously or unconsciously we tend to endow any education with those ideals which are counted upon to contribute progressively to the well-being and quality of human society. Since we are convinced that democracy thrives and grows strong on education, it is easy to presume that an inverse relationship is equally valid — that education automatically leads to the formation of democratic values and strengths.

It would seem that the philosophy of Soviet education militates against such a presumption. Nevertheless, as Soviet indoctrination has produced disillusionment with communist dogma, so Soviet educational gains in science and technology may produce disaffection with the political and economic structure of communism, stimulating a desire for change. In consequence of the advances and the spread of knowledge, it is already difficult for the Soviet Union to keep its people in the dark on the status of the economic, scientific, and cultural progress of the Western industrial societies. In this sense Soviet education is a promise both to the people now under communism and to the rest of the world. It may not be fulfilled by any direct emergence among the educated elite in the Soviet Union of the democratic political and economic ideas we associate with liberal education, but it does imply a growing capacity of the Soviet people for political and economic changes which could destroy Soviet communism.

Whether such changes can come about gradually, which seems to us very doubtful, or in a series of rapidly evolving developments, the crucial issue which will decide the future meaning and role of Soviet education and thus the future quality of Soviet society is the control over the allocation of its resources. When ultimately the Soviet people gain a decisive voice in the allocation of their intellectual

(*Concluded on page 214*)

ALEXANDER KUSKO, INC.

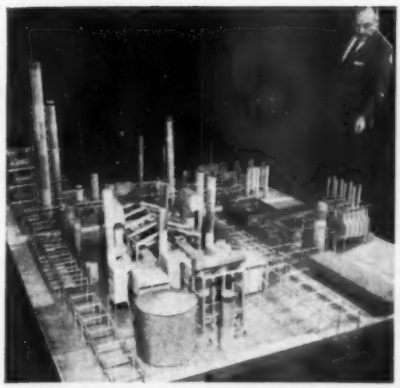
Consulting Engineers

141 Main Street Cambridge 42, Mass.
ELiot 4-4015

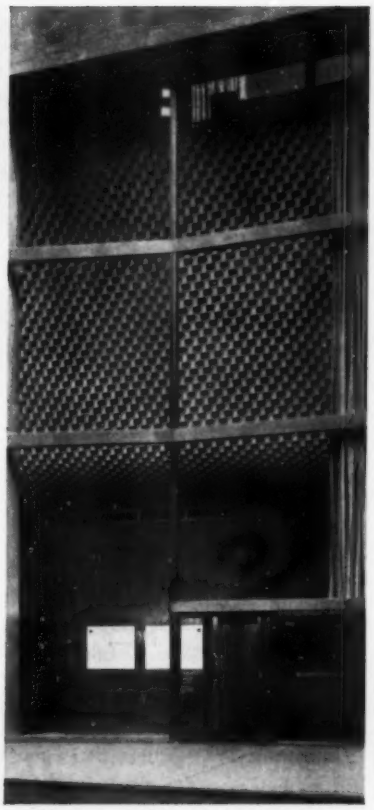
Research and Development in

Magnetics
Electric Machinery
Transistor Circuits
Control Systems

A. Kusko '44
P. N. Heller '51
J. P. Blake, Jr. '54
J. A. Gaudet '56



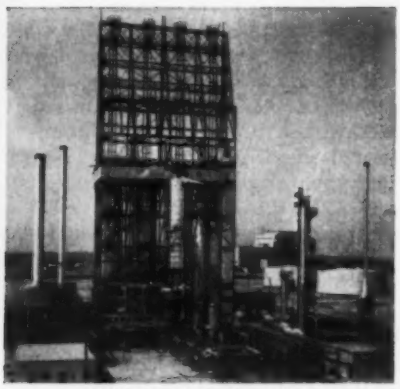
200,000,000 lb. per year ethylene plant



The Lummus Company headquarters
385 Madison Avenue, New York, N. Y.

Beryllium plant

High pressure acetylene chemicals plant



600 ton per day coking unit

Lummus New York is headquarters for design, engineering and construction

Engineers and Constructors of More Than 700 Refineries, Chemical and Petrochemical Plants of all Types and Sizes Throughout the World in the Last 50 years.

The Lummus Company headquarters are at the business crossroads of the world in New York, ready to coordinate the engineering skills of over 3,000 permanent employees located in seven branch offices and subsidiaries throughout the world.

A staff of more than 1,000 scientists, engineers and administrators contributes a wealth of skill and experience – each in his chosen field – to handle the great mass of detail involved in a modern processing plant. Few single companies in the process industries can afford to maintain the reserve of industrial experience and engineering skill that characterizes the Lummus organization.

In addition, Lummus maintains a 150,000 square foot Engineering Development Center in Newark, N. J., to bridge the practical gap between laboratory research findings and commercial plant operation. The Center has extensive pilot plant facilities in operation, and is equipped for designing and building new units.

Several recent domestic projects of The Lummus Company (pictured above) are: a 200,000,000 lb. per year ethylene plant; the world's first full scale, high-pressure acetylene chemicals plant; a beryllium metal plant; and a 600 ton per day coking unit designed for the heaviest charge ever fed to a coker.

See Lummus on your next project.

Branch offices of The Lummus Company are located at Washington, D. C.; Chicago; Houston, and Baton Rouge.

Subsidiaries are in Montreal, Caracas, London, Paris, The Hague and Bombay.

LUMMUS

ENGINEERS AND CONSTRUCTORS FOR INDUSTRY
385 MADISON AVENUE, NEW YORK 17, N. Y.

SOVIET EDUCATION FOR SCIENCE AND TECHNOLOGY

(*Concluded from page 212*)

and physical resources, Soviet educational philosophy and pattern will certainly change. When that time comes, their schools will produce fewer but better engineers. After decades of virtual captivity their scientists will once again become members of the world's scientific community. Their universities will produce perhaps fewer physicists and mathematicians, but their graduates will include economists, historians, jurists, and philosophers. Science and technology will continue to advance – but in the service of the people – and the creative genius of the emancipated peoples will also find outlets in literature, the arts, and the humanities.

The broad implications of what we have set down in this study are clear. The free nations should know the direction in which lies the real threat to their survival lest through inaction, compromise, or shortsighted expediency they themselves should unwittingly help the growth and expansion of communist power. In the long run the threat of communism will be removed if the free peoples vigorously continue – Soviet Union or no Soviet Union – to pursue their highest social goals and to maintain their combined scientific, technological, and moral superiority. But for the free nations to believe that they can somehow achieve these goals while continuing to carry on their educational efforts and all the other pursuits of life "as usual" is to refuse to face the realities of the world scene at this junction of history. If, in the face of the Soviets' superior power to allocate the resources under their control, democracy and economic progress for all nations are to prevail, and the freedom and dignity of every individual are to be attained, we free peoples must find a way to release a larger share of our aggregate resources and energy from nonessential material uses and devote them to the service of indispensable goals.

UNIVERSITIES — KEY TO AMERICA'S LEADERSHIP

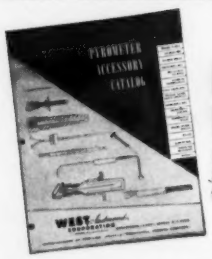
(*Concluded from page 203*)

group of men who have perceived the basic problem of education in science, and who are determined to do something about it – whatever the cost in their own time and effort.

It is comforting, too, that their plan of concerted attack on these extremely complex problems of teaching is the product of experience gained in a series of intensive military studies, carried on by Professor Jerrold R. Zacharias and his associates over the past eight or 10 years with great effectiveness.

I take comfort in observing how often the methods, as well as the products, of our military research can be converted with striking advantage to the peaceful uses of our country. It is, after all, our basic aim to live in peace with the rest of the world. Whatever science, engineering, and technology can do toward achieving this end is a net gain for all of mankind.

THERMOCOUPLES
for every industry



DATA BOOK
New 32-page file book

★ Handily lists all data (I.S.A.) and
★ Graphically shows easiest way to select precisely the best thermocouple and protective tube for each operation.
★ Lists all components, with prices and
★ Provides handy reference for stock record.

STANDARD AND SPECIAL

For furnaces, ovens, kilns, moulding machines, pipelines, freezers, etc.

For use with all standard types of temperature indicators, controllers, recorders.

We make thermocouples from matched and checked wires to insure constant millivolt output for accurate readings. Complete selection.

William C. West ('11) Chmn.
Richard K. West ('38) Pres.
Canadian Representatives:
Upton, Bradeen & James
English Plant: cable
WESTINST, London
4355C W. Montrose Ave.
Chicago 41, Illinois

FREE
write for your copy Now...

WEST *Instrument*
CORPORATION
CHICAGO
SALES OFFICES IN PRINCIPAL CITIES

M.I.T. CHAIR

A fine adaptation of the traditional Corporation chair of President William Barton Rogers . . . Sturdily made of hard maple and finished in black with trim and seal in gold . . . Each chair is factory packed in its own heavy carton to insure safe transit.

Price $27.50 shipped express collect from Gardner, Mass.

M.I.T. *Wedgwood* PLATES

Eight different specially-commissioned original drawings of the Institute by the internationally-known artist Samuel Chamberlain, '18, have been skillfully and faithfully engraved by Wedgwood craftsmen . . . and reproduced as numbered sets of eight plates on the finest quality of the famous WEDGWOOD BONE CHINA in the 10½-inch formal place setting size, with centers hand-decorated in rich sepia. . . . To enhance the beauty of the centers there is a gold banding on the rim and another circling the center view, the shoulder between being given a cream tint.

Prices, including carriage prepaid: $85 for full set of 8 plates, $45 for half-set of 4, and $25 for quarter-set of 2

When M.I.T. was "Boston Tech"

By Samuel C. Prescott '94

Here, told in terms of the men who did it, is the story of the beginning and growth of the Institute on Boylston Street to its embodiment in the great school on the Charles in Cambridge . . . xvii+350 pp. with 14 pp. of illustrations.

Price $6.00 per copy postpaid—*or* in combination with a copy of the current *1955 Alumni Register*, $8.00.

Orders will be filled by the:

Alumni Association
Room 1-290, M.I.T.
Cambridge 39, Mass.

GEARS

Made to Your Specifications

You and we can form a team—you to draw up the specifications; we to make the gears—that will be profitable to both of us. Gears of all types, all sizes, all materials. Design-engineering service available.

Custom Gears Exclusively

DIEFENDORF GEAR CORPORATION

Syracuse 1, N. Y.

DIEFENDORF GEARS

HD AT YOUR SERVICE

SPECIALIZED ENGINEERING
SPECIALIZED EXPERIENCE
SPECIALIZED MACHINERY
FOR
TWISTING · FORMING
STRANDING · BUNCHING
COTTON · JUTE · MANILA
SISAL · NYLON · DACRON
ORLON · SARAN · PAPER
POLYETHYLENE · GLASS

TEXTILE · WIRE · CORDAGE
and OTHER INDUSTRIES

HASKELL-DAWES
MACHINE CO., INC.
2231 E. Ontario Street
Philadelphia 34, Pa.

INVENTION IN FLIGHT

(*Continued from page 207*)

ventional propeller "mother" airplane. The rocket engine is the only one which will operate above 50,000 feet. Yet for some important applications, the specialized advantages more than outweigh the disadvantages.

What will be the future of air-borne man? Will his remarkable flying craft evolve further? That would depend upon the conditions for invention and development. Hindrances, such as secrecy and compartmentalization, could delay progress.

Impediments to Progress

Da Vinci's extensive aeronautical studies and inventions were completely lost from view for 300 years, and his complete works were not published until 1930. Although much independent effort was put forth during this period, other inventors failed to duplicate most of da Vinci's inventions. This fact may demonstrate that da Vinci was truly ahead of his time. At any rate, the lack of awareness of his ideas may have delayed the development of aeronautics by hundreds of years. At least subsequent early developments were along entirely different lines.

The world's first liquid fuel rocket was flown by an American scientist, Robert H. Goddard, in 1926. The first German rocket of comparable speed and power was flown more than four years later. Yet within 13 years, massive V-2 rockets were being mass-produced in the Third Reich. Not until 1949 did the United States launch a large-scale rocket, the *Viking*, a full 23 years after the first American flight test. Why did rocket development take 10 years longer in the United States than in Germany?

Several independent American groups were engaged in serious rocket experimentation. These groups attempted correspondence with Goddard, but were at best rewarded with curt notes. When asked for information on his current work, Goddard would reply that it had not yet progressed sufficiently to justify a report. It is possible that the unfortunate compartmentalization of American rocket research may have been detrimental to rapid progress.

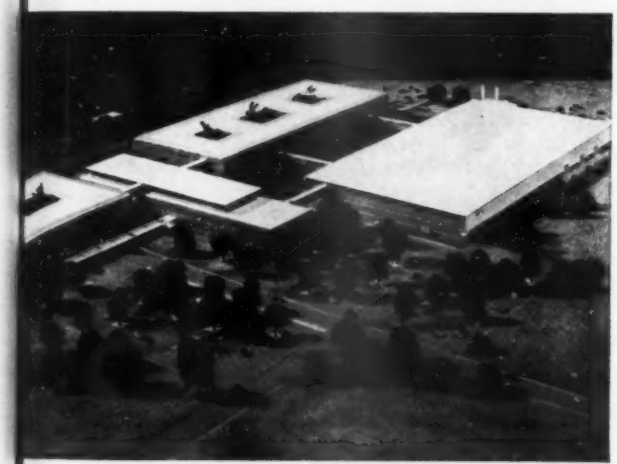
Conclusion

What implications are there here for scientific and technological progress? It means that the greatest

(*Concluded on page 218*)

SCULLY SIGNAL COMPANY
Safe Fills } with VENTALARM®
No Spills } WHISTLING TANK FILL SIGNAL
for automotive, home and diesel fuel tanks
P. Scully '15 174 Green Street, Melrose 76, Mass.
"JUST FILL 'TIL THE WHISTLE STOPS"

J. W. Marchetti, Director, Avco Electronics Research Laboratory



Pictured above is our new Research and Development Center now under construction in Wilmington, Massachusetts. Scheduled for completion in early 1958, this ultramodern laboratory will house the scientific and technical staff of the Avco Research and Advanced Development Division.

Avco's new research division now offers unusual and exciting career opportunities for exceptionally qualified and forward-looking scientists and engineers in such fields as:

Science:
Aerodynamics · Electronics · Mathematics · Metallurgy
Physical Chemistry · Physics · Thermodynamics

Engineering:
Aeronautical · Applied Mechanics · Chemical · Electrical
Heat Transfer · Mechanical · Reliability · Flight Test

Write to Dr. R. W. Johnston, Scientific and Technical Relations, Avco Research and Advanced Development Division, 20 South Union Street, Lawrence, Massachusetts.

CREATIVITY

If there is a single word that can best describe the aim and purpose of AVCO's Research and Advanced Development Division, it is creativity. We at AVCO have assembled those elements and that atmosphere which we believe are most conducive to true creative effort.

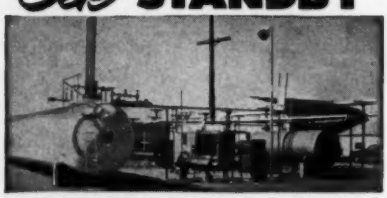
Our future progress depends on an early recognition of the difference between an *important* new idea and just a new idea. It is mere quibbling with words whether we call these things new discoveries, breakthroughs, or basic research. They are, in fact, merely the signposts of our future. The world in 1980 and the year 2000 will, in its technological aspects, be vastly different from what we know today. Yet locked somewhere on our present scientific frontiers is the knowledge that will spell out this difference. It is our purpose to help in the unlocking of that knowledge and to contribute our part to the over-all progress.

The most important ingredients of creativity are curiosity and a real will to work hard. Of only slightly lesser importance is the feedback, or close working relationship between theoretician and observing experimentalist. We at AVCO also realize that a single creative effort is the output of a man, or, at the most, of a small group of men at any one time. It is, therefore, continuously subject to the criticism of other men and some even more stultifying forces. Some of these are economic or organizational and others are of a more subtle variety. We of the AVCO management consider it our responsibility to be alert to both positive and negative factors affecting creativity. We consider the ability of our men to create for the future, the most important function of the AVCO Research and Advanced Development Division.

J. W. Marchetti,
Director, Avco Electronics Research Laboratory

AVCO
Research & Advanced Development

GAS STANDBY



Packaged 12 mcfh plant designed and built by Draketown for...

★ Utility or Industrial standby
★ Peak shaving and augmentation
★ 100% Town or plant supply

A Packaged Draketown Propane Plant will help you reduce demand charges; provide a supply of gas during curtailment periods... at the turn of a valve... or supply that outlying section or plant 100% if desired.

DRAKETOWN PROPANE PLANTS
"Good Gas Insurance"

If you have a gas problem, we can help you. We operate from coast to coast and overseas.
Phone or write today—no obligation.

DRAKE & TOWNSEND
Consulting • Design • Engineering • Construction
11 WEST 42ND STREET • NEW YORK 36 N. Y.

INVENTION IN FLIGHT

(Concluded from page 216)

progress can be achieved if there is an unimpeded flow of information on inventive problems between the scientists and engineers of the free world. Barring inventions for military purposes, where secrecy must be imposed, great advances would follow from international co-operation in science and technology. The individuals who can provide a breakthrough are rare indeed—and no nation has a monopoly on genius. The invention of the airplane depended on contributions from many countries. Great possibilities lie ahead for the congregation of nations that can reap the benefits of their assembled talents. Whether the free world or the collective world will be so favored remains to be seen.

Text References

1. Pearson, Oliver P., "The Metabolism of Hummingbirds," *Scientific American*, **188**:69, No. 1 (Jan., 1953).
2. Welty, Carl, "Birds as Flying Machines," *Scientific American*, **192**:88, No. 3 (March, 1955).
3. Sutton, O. G., *The Science of Flight*, page 164 (Harmondsworth, England: Penguin Books, 1949).
4. Ley, Willy, *Rockets, Missiles, and Space Travel*, page 87 (New York: The Viking Press, Inc., 1951).
5. Ley, *op. cit.*, page 89.
6. Ley, *op. cit.*, page 88.
7. Stillson, Blanche, *Wings*, page 242 (New York: Bobbs-Merrill Company, Inc., 1954).
8. Stillson, *op. cit.*, page 248.
9. Wilson Grove, *Great Men of Science*, page 366 (Garden City, N.Y.: Garden City Publishing Co., 1929).
10. Hunsaker, Jerome C., *Aeronautics at the Mid-Century*, page 12 (New Haven: Yale University Press, 1952).
11. Ayres, Eugene, "The Fuel Situation," *Scientific American*, **195**:43, No. 4 (October, 1956).

Table 1 References

1. Chapel, C. E., *Jet Aircraft Simplified*, page 151 (Los Angeles: Aero Publishers, Inc., 1950).
2. Lessing, L. P., "Helicopters," *Scientific American*, **192**:36, No. 1 (January, 1950).
3. Sutton, G. P., *Rocket Propulsion Elements*, page 252 (New York: John Wiley and Sons, Inc., 1949).
4. Gray, George W., *Frontiers of Flight*, page 354 (New York: A. A. Knopf, 1948).
5. C. A. A. Technical Manual No. 107, *Aircraft Power Plant Handbook*, page 322 (Washington, D. C.: U. S. Department of Commerce, January, 1949).

Table 2 References

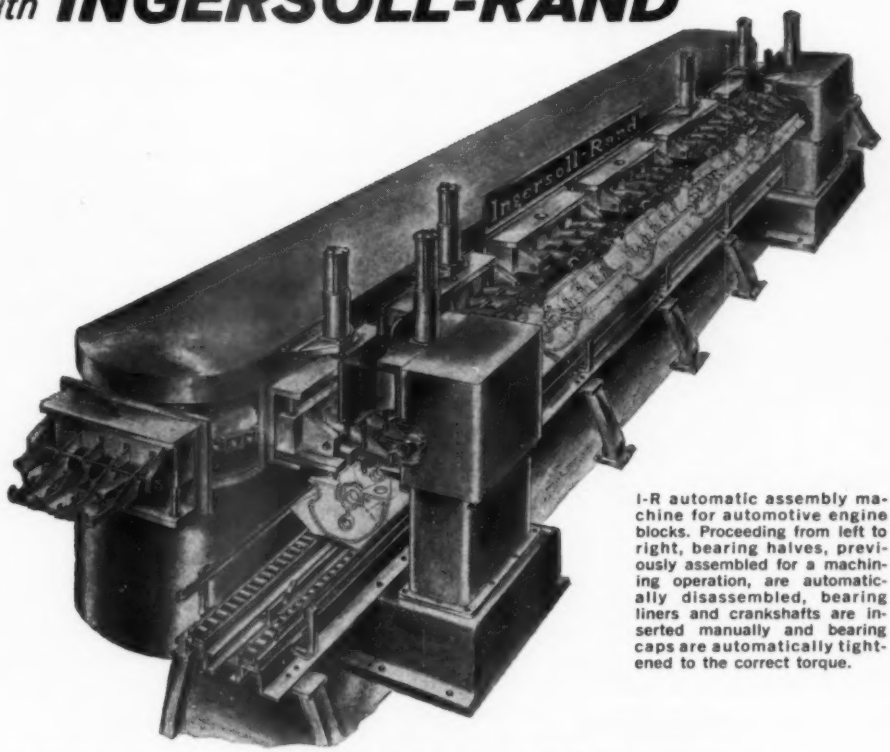
1. Stillson, Blanche, *Wings* (New York: Bobbs-Merrill Company, Inc., 1954).
2. Storer, John H., "Bird Aerodynamics," *Scientific American*, **186**:24, No. 4 (April, 1952).
3. Welty, Carl, "Birds as Flying Machines," *Scientific American*, **192**:88, No. 3 (March, 1955).
4. Pearson, Oliver P., "The Metabolism of Hummingbirds," *Scientific American*, **188**:69, No. 1 (Jan., 1953).
5. Sturkie, Paul D., *Avian Physiology*, pages 50, 119 (Ithaca, N. Y.: Comstock Publishing Associates, 1954).

Table 3 References

1. Faries, V. M., *Applied Thermodynamics*, page 205 (New York: Macmillan Company, 1949).
2. Pendray, G. E., *The Coming Age of Rocket Power*, page 18 (New York: Harper and Brothers, 1947).

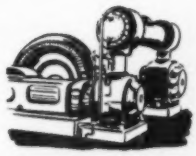
YOUR LEADERSHIP CAREER

with INGERSOLL-RAND

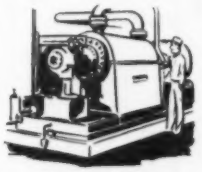


I-R automatic assembly machine for automotive engine blocks. Proceeding from left to right, bearing halves, previously assembled for a machining operation, are automatically disassembled, bearing liners and crankshafts are inserted manually and bearing caps are automatically tightened to the correct torque.

also means LEADERSHIP in

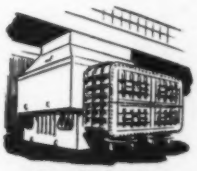


Compressors and Blowers

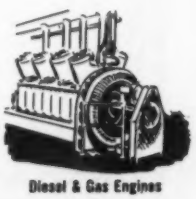


Centrifugal Pumps

Rock Drills



Steam Condensers



Diesel & Gas Engines

If you are interested in automation . . .

Here's what Air-Tool Engineering at Ingersoll-Rand can mean to you

AUTOMATION, today, is the magic word that is opening new horizons for cost-saving economy in practically every industry. Things that used to be done by hand are now being done automatically. Here is a rapidly growing field which offers fine opportunities for you as a mechanically minded engineer.

Many interesting engineering problems arise in the design, development and experimental work on such machinery, and creative engineering is necessary to solve them. Practical engineering ability is also needed for installation and initial operation of such equipment. The early studies of customers' needs and automation equipment sales are also challenging jobs.

Ingersoll-Rand is a recognized leader in designing and building these labor-saving air and electric tools, and is also one of the country's leading manufacturers of air compressors, pumps, rock drills, gas and diesel engines, vacuum equipment. All of these products depend heavily on advanced engineering in their design, manufacture and field application.

Then there are the advantages of living in Athens, Pa., where Ingersoll-Rand builds automation equipment. The picturesque Pennsylvania hills provide many recreational advantages that are particularly appealing to the outdoor man.

If you are looking for a leadership career with long-range job security and excellent opportunities for advancement, you'll find it at Ingersoll-Rand.

For further details, contact your Placement Office, or write to Ingersoll-Rand, 11 Broadway, New York 4.

OPPORTUNITIES FOR ENGINEERS NOW AVAILABLE:

- Sales Engineering
- Design Engineering
- Production Engineering
- Business Engineering

Ingersoll-Rand

8-733 **11 Broadway, New York 4, N. Y.**

Among the many graduates of Massachusetts Institute of Technology at Ingersoll-Rand are:
L. C. Hopton, 1926, *First Vice-President and Secretary;* P. J. Bentley, 1925, *Vice-President*

Fairfield & Ellis
INSURANCE

SIXTY CONGRESS STREET
BOSTON

TREND OF AFFAIRS

(*Continued from page 200*)

and won two letters there. His home is in Portsmouth, N.H.

Joseph T. Bowers, Jr., '57, captain of the year's team, played number four position. His best effort was against Bowdoin when he won 5 and 4 while shooting a 77. Joe hails from Monterrey, Mexico.

Charles E. Leonard, 3d, '58, a transfer student from Middlebury College played number 5. Had he not missed the indoor sessions and the first three matches, he would have had the chance to move up the ladder. Charlie won all but one of his individual matches. He will be ineligible next year, having played three years at Middlebury. His home is in Philadelphia.

William R. T. Smith, '59, of Winnetka, Ill., Joseph J. Mogilner, '59, of Birmingham, Ala., and Jack M. Fischer, '59, of Pittsburgh, alternated at the 6 and 7 spots. They were about of equal ability which gave the team important depth.

Lacrosse

Varsity – In terms of the Chinese calendar, this was the year of the snake bite. Grief fell on trouble, starting with medical disqualification of the goalie and withdrawal from school of a potential All New England mid-fielder. It continued with injury after

(*Continued on page 222*)

ESTABLISHED 1818

FOR A VACATION WHERE IT'S WARM
our distinctive and colorful sportwear

Brooks Brothers have long been noted for sportwear that is casual in appearance...exacting in quality and workmanship. Our active and spectator sport clothing for cruise and southern resort wear is highlighted by our exclusive Brooksweave* Odd Jackets, Odd Trousers and Bermuda length shorts that require no pressing after laundering. Illustrated brochure upon request.

Dacron and cotton. Trade-mark registered.

111 BROADWAY,
NEW YORK 6, N. Y.

46 NEWBURY, COR. BERKELEY,
BOSTON 16, MASS.

74 EAST MADISON STREET,
CHICAGO 2, ILL.

727 WEST SEVENTH ST.,
LOS ANGELES 17, CALIF.

165 POST STREET,
SAN FRANCISCO 8, CALIF.

ESTABLISHED 1818
Brooks Brothers,
CLOTHING
Men's Furnishings, Hats & Shoes

346 MADISON AVENUE, COR. 44TH ST., NEW YORK 17, N. Y.
BOSTON • CHICAGO • LOS ANGELES • SAN FRANCISCO

COMBUSTION'S

SCHEDULE OF "Main Events" FOR '58

Dedication of World's Largest, Privately Owned, Integrated Facilities for Nuclear Research, Development and Manufacture

C-E's $15,000,000 Nuclear Division at Windsor, Connecticut. Ground broken December 1955; construction completed in late '57; dedication in Spring of '58.

Construction of Nuclear Submarine Prototype

At C-E Nuclear Division, Windsor, Connecticut. First nuclear submarine prototype to be designed and built at other than AEC-owned facilities.

Shipment of Largest and Most Complex Nuclear Vessel Built to Date

Reactor vessel for Enrico Fermi Nuclear Power Station.

Completion of Manufacture of World's Highest Pressure, Highest Temperature Boiler

5000 pounds per square inch; 1200 deg. Fahr.

Engineering and Partial Manufacture of World's Largest Boiler

First boiler ordered to serve a turbine generator with a capacity as high as 500,000 kw.

Completion of Installation of World's Highest Capacity, Highest Pressure, Highest Temperature Package Boilers

Two completely shop-assembled boilers, one with a capacity of 100,000 pounds of steam per hour, and one to operate at a pressure of 1800 pounds per square inch and 1050 deg. Fahr.

These are some of the achievements which will maintain Combustion's leadership in 1958 in its major field — the creation and building of advanced designs of equipment for the generation of power or heat from conventional or nuclear fuels.

And, in another significant area, Combustion expects to set a new record this year — *the largest volume of shipments and billings in its history.*

COMBUSTION ENGINEERING

Combustion Engineering Building • 200 Madison Avenue, New York 16, N. Y.

C-E C-136P

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS; PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING EQUIPMENT; PRESSURE VESSELS; SOIL PIPE

communications systems engineers

with extensive experience in:

RF audio and digital data handling circuits

are invited to inquire about senior openings by writing Mr. J. Melville

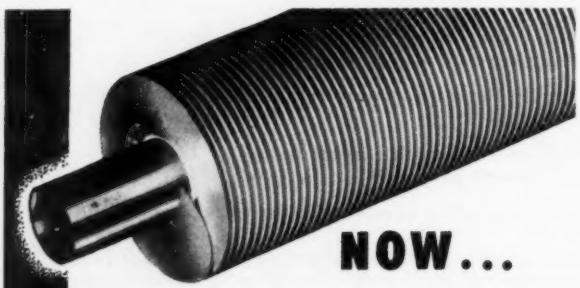
•

the West's leader in advanced electronics

HUGHES

RESEARCH & DEVELOPMENT LABORATORIES

Hughes Aircraft Co., Culver City, Calif.



NOW...

Even More
Heat-Exchange Capacity
Even Less **Air Friction**

with *AEROFIN Smooth-Fin*
Heating and Cooling Coils

Write for Bulletin S-55

AEROFIN CORPORATION
SYRACUSE 1, N. Y.

TREND OF AFFAIRS

(Continued from page 220)

injury to individuals placed by necessity in unfamiliar key positions.

Despite the difficulties, the squad won two games in a 12-game schedule and was defeated by Harvard, New Hampshire, and the University of Massachusetts in close, hard-fought contests.

Richard A. Johnson, '58, and Huber R. Warner, '58, were elected co-captains at the end of the season. Johnson, an aggressive defense man, was named the outstanding player for the season.

Freshman – There were no experienced freshman lacrosse players; none who had played on a high school or preparatory school varsity, and only two who had been introduced to the game in preparatory school. However, as the practice sessions progressed, it became apparent that there were several good athletes and an abundance of enthusiasm and spirit. This was clearly illustrated in our first scrimmage with the varsity, during which our play, although not particularly skillful, was aggressive to the point of our being referred to by several varsity players as "Charlie Batterman's Hatchet Men!"

This was good. We were tough, aggressive, and learning fast. We won our first game with Lawrence Academy, 2–1. Then came a crushing defeat at the hand of Harvard, 17–1. Concern over a possible loss of spirit was dispelled by an overtime win over Nichols Junior College, 8–7, in a very hard-fought game, with Charles R. Conn, 2d, '60, our acting captain, scoring 5 goals including the winning overtime goal. There followed another overtime game with the University of New Hampshire freshmen, resulting in a tie, 2–2. According to their coach, this event was the first time that the University of New Hampshire did not beat M.I.T. As expected, Tech lost the next game with Andover, 9–1. An interesting note on this game: M.I.T. penalties 12; Andover penalties 3.

Our next game, against Governor Dummer, was the high light of our season and led to an upset victory, 8–7. We lost the next three games, one in overtime, despite the outstanding play of Donald F. DeReynier, '60, and Daniel N. Michael, '60, and a superlative job by our goalie, Phillip F. Frink, '60.

Having won three and tied one was the best record for an M.I.T. freshman lacrosse team. Starting as the

(Continued on page 224)

William H. Coburn & Co.
INVESTMENT COUNSEL
68 Devonshire Street
Boston

For Your Investments . . .

Our Trust Department offers . . . Experienced Professional Management

Successful investing is a full-time job, one that should not be relegated to your spare time or sandwiched in between trips. This task requires special training and experience.

At The New England Trust your portfolio benefits from investment decisions based on:

CAREFUL RESEARCH — into the important sources of business and economic information

GROUP JUDGMENT — of our Trust Committee and Senior Investment Officers

With this type of investment supervision, you may have the bank provide safekeeping for your securities, keep complete records of all transactions and, in addition, at tax time prepare a special summary of all figures needed for your annual tax returns.

Ask one of our Officers or write to our Trust Department for more details about our Investment Advisory Service.

The New England Trust Company

135 DEVONSHIRE STREET, BOSTON 7, MASS.
Telephone: HAncock 6-8005
Back Bay Branch: 99 Newbury Street

Member of the Federal Deposit Insurance Corporation

Incorporated 1869

TREND OF AFFAIRS

(*Continued from page 222*)

team did, completely inexperienced, they finished as a good lacrosse team, by freshman standards. The varsity will indeed be bolstered by Frink, our great goalie, and by the excellent defense play of John Y. Cadwallader, '60, Nathaniel Florian, '60, George B. Felts, Jr., '60, and the mid-field and attack play of Conn, DeReynier, Michael, and Bruce Craig, '60. Bruce was probably our most improved player, and did a fine job.

Tennis

Varsity – The varsity tennis team started its spring season with a southern trip during the Easter vacation. Eight players, the manager, and the coach made the trip. The southern trip proved to be a very successful one in all respects. The team returned with a record of 2 wins, 1 loss, and 1 incomplete (due to darkness). The incomplete match was with North Carolina State, and ended with N.C. State leading 4–3 with the Number One Doubles at one set all and M.I.T. leading 3–2 in the third set. In the Number Two Doubles, M.I.T. was leading 11–10. M.I.T. won the Number Three Doubles.

Our team suffered a rather severe blow when, for different reasons, we lost four of our first six players who had been with us during the fall of 1956. Despite the loss of so many players, we still had an interesting season, winning 4 matches and losing 10. Three of the 10 matches ended with scores of 5–4, all of which we might have won. Our 5–4 loss to Brown was particularly exciting when the match was finally decided, 8–6 in the third set of the Number Three Doubles in semidarkness.

With about 18 active varsity players and about 25 freshmen, there would seem to be a need for another team where players can get the competition that they need to maintain their interest and develop their games. The establishment of a junior varsity team and schedule could very well meet this need.

Freshman – The total season record for the freshman tennis team was three wins and five losses. The team members were eager to learn. The most promising ones are: Thomas M. Cover, '60, Robert I. Carr, Jr., '60, and Robert M. Hodges, Jr., '60. Others who could also develop into good players are: George P. Koo, '60, Tony C. Hill, '60, Michael H. Seiler, '60, William C. Shih, '60, David A. Aaker, '60, and Ivan M. Kasser, '60.

A few players deserve special mention. Hill has basically a good game. Norman K. Dorf, '61, was playing the seventh position but left just before the last two matches. Cover, Carr, and Hodges have very good court attitudes and are very eager to learn. They should strengthen the varsity team.

Among a few of the players, who may not realize that concentration is such a large part of tennis, there was a lack of concentration on the court. They will learn, although so far they have had too little experi-

(*Concluded on page 226*)

SPECIAL REPORT

Mr. JOHN B. COOK — NEW YORK LIFE AGENT

at LANSING, MICHIGAN

BORN: April 5, 1927.

EDUCATION: Michigan State College, B.A., 1951.

MILITARY: U.S. Navy, South Pacific Area 1944–5.

PREVIOUS EMPLOYMENT: Salesman, national manufacturer of consumer and industrial products.

REMARKS: Former industrial salesman John B. Cook joined New York Life's Lansing, Michigan, Office on September 1, 1952. In the little more than 5 years since then, this young Navy veteran's impressive sales record has qualified him for the Top Club — an honorary organization of sales leaders from the Company's field force of more than 7,000 representatives. In 1957 John Cook, for the second consecutive year, received the National Quality Award from the National Association of Life Underwriters. Truly an excellent record and one which is a good indication of John B. Cook's future success potential with the Company he represents.

Note

John B. Cook, after five years as a New York Life representative, is already established in a career that can offer security, substantial income, and the deep satisfaction of helping others. If you'd like to know more about such a career for yourself with one of the world's leading life insurance companies, write:

NEW YORK LIFE INSURANCE CO.
College Relations Dept. F-26
51 Madison Avenue, New York 10, N.Y.

New books from *The Technology Press*

SOVIET EDUCATION FOR SCIENCE AND TECHNOLOGY
by Alexander Korol $8.50

THE TAO OF SCIENCE
An Essay on Western Knowledge and Eastern Wisdom
by R. G. H. Siu $4.25

CERAMIC FABRICATION PROCESSES
Slip Casting
Pressure Fabrication
Plastic Forming
Drying and Firing
Some Special Processes
edited by W. David Kingery $9.50

Published jointly with John Wiley & Sons
ORDER FROM
The Technology Press of M.I.T.
Cambridge 39, Mass.

SPECIALISTS in Pre-Fabricating PIPING

ALBERT PIPE SUPPLY COMPANY, INC.

STEEL PIPE: Wrought Iron • Steel • Structural • Cast Iron • Copper-Steel • Electric Weld • Seamless • Spiral, Lap & Butt Weld • Shore-Dredge • Speed-Lay

CEMENT-ASBESTOS PIPE: For sewerage and water mains where corrosion is a problem.

ALUMINUM PIPE: In standard and light walls. All accessories stocked.

PLASTIC (PVC) PIPE

SPEED-LAY: Complete packaged PIPE SYSTEM for fast-laying, temporary and semi-permanent lines for water, compressed air and other services. Write for catalog.

VALVES, FITTINGS & FLANGES: Tube Turns • Dresser • Victaulic • Cast Iron or Steel • Forged Steel • Special Alloys • Water Main

PILING PIPE: Cast Steel and Iron Points • Plates and Shoes • Cast Steel • Malleable Iron Sleeves

COMPLETE FACILITIES for Bending, Coiling, Beveling, Swedging, Flanging, Grooving, Welding, Cutting to Sketch, and Threading to most rigid requirements. Bitumastic or Cement lining — Testing — all to Standard specifications.

S.G. ALBERT '29 • A.E. ALBERT '56

103-1 VARICK AVE., BROOKLYN 37, N. Y.
Tel.: HYacinth 7-4900

The TREDENNICK-BILLINGS CO.

Construction Managers *Building Construction*

K. W. RICHARDS '07 H. D. BILLINGS '10 C. C. JONES '12 F. J. CONTI '34

10 HIGH STREET BOSTON, MASSACHUSETTS

BDC 1865 • BDC 1865 • BDC 1865 • BDC 1865 • BDC 1865 • BDC 1865 • BDC 1865 • BDC 1865 • BDC 1865 • BDC 1865 • BDC 1865 • BDC 1865

Boit, Dalton & Church

INSURANCE SINCE 1865

89 BROAD STREET, BOSTON 10 • *Telephone* HUbbard 2-3100

FREDERIC C. CHURCH CHAS. COLBY HEWITT
COLLINS GRAHAM STANLEY H. KING FRANK W. HUMPHREY
MYRON E. WATSON ROBERT W. HARDING

ENGINEERS
HN
CONSTRUCTORS

HOLMES & NARVER, INC.

ENGINEERS • CONSTRUCTORS

JAMES T. HOLMES
M.I.T. '14

D. LEE NARVER
STANFORD '14

828 S. Figueroa St., Los Angeles 17, California

Telephone TRinity 8201

SYSKA & HENNESSY, INC.

Engineers

John F. Hennessy '24 — John F. Hennessy, Jr. '51

S H

DESIGN · CONSULTATION · REPORTS
POWER PLANT · WASTE DISPOSAL · WATER SYSTEMS
New York City

CHAUNCY HALL SCHOOL

Founded 1828. The School that specializes in the preparation of students for the Massachusetts Institute of Technology.

Ray D. Farnsworth, *Principal* 533 Boylston Street, *Boston, Mass.*

LEONARD CONSTRUCTION COMPANY

Engineers and Contractors

SINCE 1905

IN THE AMERICAS AND FAR EAST
37 South Wabash Ave.
Chicago

R/L

ROTH LABORATORY
FOR PHYSICAL RESEARCH

Serving Industry in these fields—

ELECTRONICS — MATHEMATICAL ANALYSIS
AUTOMATION — RESEARCH MANAGEMENT
MEDICAL PHYSICS — ANALOG COMPUTERS
ULTRASONICS — INSTRUMENTATION

Wilfred Roth
M.I.T. '48
Columbia '43

1240 MAIN STREET • JAckson 7-8474
HARTFORD 3, CONNECTICUT

TREND OF AFFAIRS

(Concluded from page 224)

ence. Lack of experience also has shown up in other places, mostly in doubles play.

Track

The varsity track team finished a very average season with only one win over Williams College during their spring meets. The showing was due to lack of suitable training conditions during the late winter workouts. This cold weather prevented the runners from working on the boards, which is so important to the Tech runners, as they need time to get in good condition. This proves the M.I.T. need for an indoor cage to produce a winning team.

The season of 1957–1958 will be stronger, as a number of freshmen have shown promise on the track and field events. They lost only one dual meet to Governor Dummer, winning over Tufts, New Hampshire, Northeastern University, and Moses Brown.

The varsity team scored only two points in the New Englands. Because of examinations, only eight men competed at Brown University in this meet and one man reported at the IC4A's in New York's Randall's Island. Edward L. Hoyt, '57, scored one point there in the hammer, fifth place. The team is looking forward to next season with interest.

In a future issue of The Review we expect to include résumés on some of the 1957 fall sports: on varsity soccer, prepared by Coach Charles Batterman; on freshman soccer, prepared by Coach Benjamin R. Martin, Jr.; and on sailing, by Walter C. Wood, '17.

meissner
Engineers

consultants • engineers • constructors

Processing plants. Bulk materials handling and storage. Conveying systems. Ore and minerals processing. Bridge, expressway and interchange design.

JOHN F. MEISSNER ENGINEERS, INC.
300 West Washington Street
Chicago 6, Illinois
ANdover 3-1944

R. C. MEISSNER '43

LOCKWOOD GREENE
ENGINEERS—ARCHITECTS

Professional Service from Site Selection to Plant Completion

Plant Location Studies
Site Investigations
Complete Design
Supervision of Construction

REPORTS — APPRAISALS

New York — BOSTON, MASS. 316 STUART ST. — Spartanburg, S. C.

PROFESSIONAL CARDS

JACKSON & MORELAND, INC.

Engineers and Consultants

DESIGN AND SUPERVISION OF CONSTRUCTION
REPORTS—EXAMINATIONS—APPRAISALS
MACHINE DESIGN—TECHNICAL PUBLICATIONS

BOSTON NEW YORK

GANNETT FLEMING CORDDRY AND CARPENTER, INC.

Engineers

HARRISBURG, PA.
Branch Offices:
Pittsburgh, Pa. Daytona Beach, Fla. Philadelphia, Pa.
Expressways, Toll Roads, Bridges and Airports. Traffic & Parking. Dams, Water Works, Sewage, Industrial Wastes and Garbage Disposal. Appraisals, Investigations and Reports.

EADIE, FREUND & CAMPBELL

CONSULTING ENGINEERS

500 FIFTH AVENUE NEW YORK 36, N. Y.

Mechanical — Electrical — Sanitary
Air Conditioning — Power — Process Layouts

James K. Campbell '11

METCALF & EDDY

Engineers

Water, Sewage, Drainage, Refuse and
Industrial Wastes Problems
Airports, Laboratory, Valuations
Statler Building, Boston 16, Mass.

THE KULJIAN CORPORATION

Consultants • Engineers • Constructors

UTILITY • INDUSTRIAL • CHEMICAL

Power Plants (Steam, Hydro, Diesel), Textile Plants, Water & Sewage Works, Oil Refineries, Pipe Lines, Army & Navy Installations, Air Fields, Hangars

H. A. Kuljian '19 A. H. Kuljian '48

1200 NO. BROAD ST., PHILADELPHIA 21, PA.

FABRIC RESEARCH LABORATORIES, INC.

Research, Development, and Consultation
In the Fields of Fibrous, Organic, and Related Materials

1000 Providence Highway Dedham, Mass.
(At Route 128 and U.S. 1 Interchange)

W. J. HAMBURGER, '21 K. R. FOX, '40 E. R. KASWELL, '39

GILBERT ASSOCIATES, INC.

ENGINEERS AND CONSULTANTS
607 WASHINGTON ST., READING, PA.

Malcolm G. Davis '25, *Vice President* Allen W. Reid '12, E. C. Edgar '35

Steam, Hydro, Diesel Power Plants; Industrial Structures; Plant Safety, Labor Relations, Utility Rates, Valuations, Reports; Large Scale Purchasing; Industrial Laboratory

New York • Washington

FAY, SPOFFORD & THORNDIKE, INC.

Engineers

Airports, Bridges, Turnpikes
Water Supply, Sewage and Drainage
Port and Terminal Works, Industrial Buildings
Designs Investigations
Supervision of Construction

Boston, Massachusetts

CLEVERDON, VARNEY & PIKE

Consulting Engineers

HERBERT S. CLEVERDON '10 WALDO F. PIKE '15
JOHN A. DOW '23 HAROLD E. PROCTOR '17

Structural Designs Foundations
Heating, Ventilating, Electric and Plumbing Designs, Industrial Buildings, Reports, Investigations

120 TREMONT STREET BOSTON 8, MASS.

MAURICE A. REIDY

Consulting Engineer

BRIDGES BUILDINGS
STRUCTURAL DESIGNS FOUNDATIONS
CONSTRUCTION CONSULTANT AND ARCHITECTURAL ENGINEER

Estimates and Appraisals

101 TREMONT STREET BOSTON, MASS.

CHARLES NELSON DEBES AND ASSOCIATES

ENGINEERS AND CONSULTANTS
Architectural — Mechanical — Electrical — Structural — Sanitary
Industrial, Commercial and Municipal Projects
915 EAST STATE ST. ROCKFORD, ILL.
C. N. DEBES '35

MORAN, PROCTOR, MUESER & RUTLEDGE

CONSULTING ENGINEERS

Foundations for Buildings, Bridges and Dams; Tunnels, Bulkheads, Marine Structures, Soil Studies and Tests; Reports, Design and Supervision

WILLIAM H. MUESER '22 PHILIP C. RUTLEDGE '33

415 Madison Ave., New York 17, N. Y.

BREWER ENGINEERING LABORATORIES

Consulting Engineers

Electric Strain Gage Testing • Stress Analysis
Strain Gage Amplifiers • Strain Gage Switches
High Temperature Strain Gages

MARION, MASS. TEL. 103

G. A. Brewer '38 S. P. Cammack '57

CAPITOL ENGINEERING CORPORATION

CONSULTING ENGINEERS
Design and Surveys
Roads and Streets
Sewer Systems Water Works
Planning Airports
Bridges • Turnpikes • Dams
Executive Offices
DILLSBURG, PENNSYLVANIA
Washington, D. C. Saigon, Vietnam Rochester, N. Y.
Robert E. Smith '41, Vice President

and the prophet replied:
*"It is well to give when asked, but it is better to give unasked, through understanding."**

Gifts by Will

TO THE
Massachusetts Institute of Technology

The tale is told of Almustafa, the prophet, who, having awaited for many years the ship that would return him to the place from whence he came, was making the final descent to the shore when the folk of Orphalese crowded about him. They besought him before departing to "disclose us to ourselves, and tell us all that has been shown you of that which is between birth and death."

With words of wisdom, an answer appropriate was given to the woman holding a baby, to the ploughman, to the merchant. Begged one, "Speak to us of GIVING," and the prophet replied:

> "It is well to give when asked, but it is better to give unasked, through understanding;
> And to the open-handed the search for one who shall receive is joy greater than giving. All you have shall some day be given;
> Therefore give now, that the season of giving may be yours and not your inheritors'."

Through the years the prophet's words have held true, for even today he who "through understanding" includes the MASSACHUSETTS INSTITUTE OF TECHNOLOGY as a beneficiary in his will can experience thereby a two-fold satisfaction. The successful culmination of his search for a worthy recipient and the anticipated results his generosity will assist in accomplishing. These satisfactions give an added value to the span of man's days and project his usefulness to his fellowmen far into the future.

The Massachusetts Institute of Technology because of the high quality of the education given its students, its effective research work for aiding America in peace as well as in war, and the high character of its governing body and academic staff qualifies as an institution for serving our American ideals for the present and in the years to come.

But the search, the finding, and the anticipated accomplishments are not enough; for without the properly-worded record, man's plan for the future may go awry. Hence the prophet's importuning, "— give now," should be heeded. The giving need not be an immediate physical transaction, for written directions replace the spoken word when the speaker is no longer present, and a donor can frequently make by will a gift which is larger than he can make while living. Truly, *"it is well to give when asked, but it is better to give unasked, through understanding."*

A booklet "Gifts by Will," outlining different forms of bequests to M.I.T., is available to you or to your attorney by writing to:

Director of Development
Massachusetts Institute of Technology
Cambridge 39, Massachusetts

* "The Prophet" by Kahlil Gibran

THE UHDE MERCURY CELL is designed

With Collaboration, and Chlor-Alkali Producing Experience, of

FARBWERKE HOECHST AG
FARBENFABRIKEN BAYER AG

which are two of the major users of mercury cells for high purity Caustic Soda

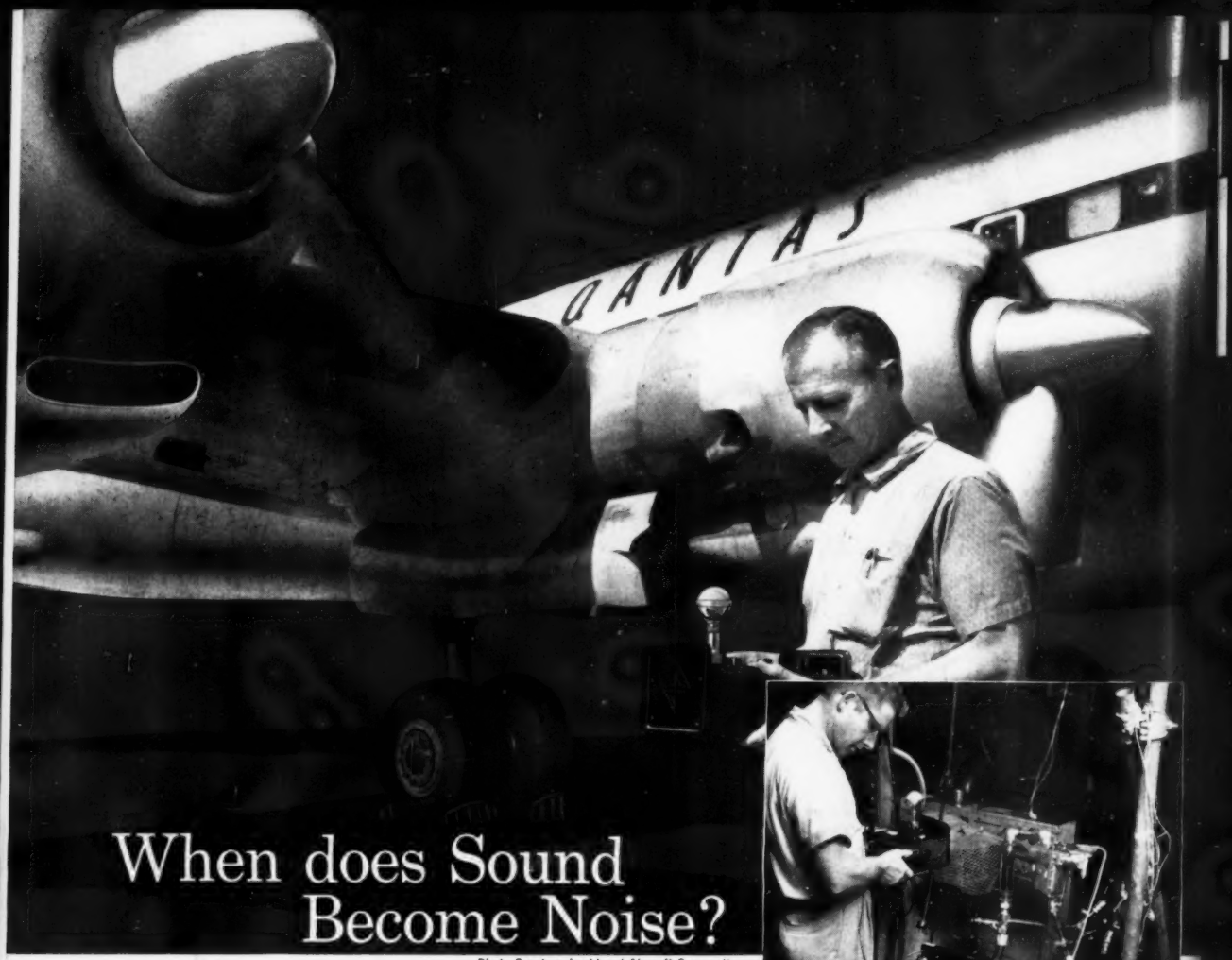
UHDE
MERCURY CELLS
ARE INSTALLED IN:

United States
Germany
Brazil
Venezuela
Great Britain

CHEMICAL
PROCESS
DESIGN

THE **UHDE CORPORATION**

350 FIFTH AVENUE, NEW YORK I



When does Sound Become Noise?

Photo Courtesy Lockheed Aircraft Corporation

Evaluating Noise by Octave-Band Methods preliminary to soundproofing a hydraulic-pressure generating system at Lockheed's test laboratory. The spectral distribution of noise determined with the G-R Octave-Band Analyzer defines the problem and aids in the prescription of proper soundproofing treatment (Sound-Level Meter serves as preamplifier for Analyzer).

Unless you can calibrate your ear, the only positive way to answer this question is by accurate measurement with instruments. Subjective results are often misleading and provide only partial answers. For accurate and complete results, industries specify General Radio sound-measuring equipment. This fully-integrated line features instruments for sound-level measurements of either high-, medium-, or low-level sounds; sound analyzers for either narrow- or wide-band analysis; impact-noise analyzers; vibration meters and analyzers; and a complete line of accessories to further extend system versatility. Write for "The Sound Bulletin" and get the complete story on sound measurement.

Type 1551-A Sound-Level Meter, **$385**

Type 1555-A Sound-Survey Meter, **$150**

Type 1556-A Impact-Noise Analyzer, **$210**

Type 1550-A Octave-Band Analyzer, **$535**

Type 762-B Vibration Analyzer, **$585**

Type 761-A Vibration Meter, **$510**

Type 760-B Sound Analyzer, **$520**

GENERAL RADIO Company

275 Massachusetts Avenue, Cambridge 39, Mass., U.S.A.

Broad Avenue at Linden, Ridgefield, N. J. **NEW YORK AREA** 1000 N. Seward St. **LOS ANGELES 38**

8055 13th St. Silver Spring, Md. **WASHINGTON, D. C.** 1150 York Road, Abington, Pa. **PHILADELPHIA**

1182 Los Altos Ave., Los Altos, Calif. **SAN FRANCISCO** 6605 W. North Ave., Oak Park, Ill. **CHICAGO**

In **CANADA:** 99 Floral Parkway, **TORONTO 15**

All G-R Products are now covered by a *2-Year Warranty*

dproof-
labora-
Octave-
proper
ifier for

56-A
r. $210

. $585

y